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ABSTRACT

Technical English differs from everyday English because of the specialized contexts in which it is used and because of the specialized interests of scientists and engineers. This text provides exercises in technical and scientific exposition in the following fields: mathematics, physics, temperature effects, mechanics, dynamics, conservation of energy, gases and liquids, heat, sound, optics, light energy, magnetism and electricity, chemistry, plastics engineering, atomic energy, radioactivity, nuclear reactors, strength of materials, machine elements, civil engineering, construction engineering, concrete structures, architecture, power and mechanical engineering, electrical engineering, electronics, electronic data processing, and agriculture and forestry. Each lesson contains the following sections: (1) a discussion of the topic and an explanation of technical terms in context; (2) reading comprehension questions and problems; (3) an English-German glossary of important terms; (4) a grammar section containing examples in English and German, and explanations in German; (5) word study and symbols; and (6) writing exercises including translation exercises. Appendices deal with vocabulary, symbols, abbreviations, differences between American and British English, and pronunciation. (AMH)

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Geistes- und Sozialwissenschaften

12.2

Scientific and Technical English

Jaroslav Vaclavik

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VORWORT

Die vorliegenden Lehrtexte bieten in ihren 30 Lektionen eine Einführung in das TECHNISCHE ENGLISCH für die Studierenden an höheren technischen Lehranstalten und Technischen Hochschulen. Sie bezwecken, die Bedeutung von fachtechnischen Ausdrücken und ihre Anwendung dadurch wiederzugeben, dass sie in den entsprechenden Kapiteln im Text aufgeführt werden, ein Ziel, das nicht nur durch ein Wörterbuch zu erreichen ist. Die Lektüre eines zusammenhängenden Textes vermittelt eine eingehendere und lebendigere Kenntnis der fachtechnischen Ausdrucksweise. Die Uebungen sollen den Studierenden helfen, sich die neuen Wendungen einzuprägen. Es wurde versucht, das Lehrmaterial weitgehend den Belangen und Zielen der Fremdsprachenausbildung im Hoch- und Fachschulbereich anzupassen. Wissenschaft und Technik erfordern, dass der qualifizierte Fachmann ständig wissenschaftliche Informationen aus fremdsprachigen Originalquellen gewinnt und sie für die eigene Arbeit nutzt. Er muss zudem in der Lage sein, sich aktiv am wissenschaftlichen Erfahrungs- und Gedankenaustausch in der Fremdsprache zu beteiligen. Nur gewissenhaftes Studium, häufiges Nachprüfen, ob neu erlernte Fachausdrücke immer in richtiger Sinngebung angewandt werden, stetiges Ergänzen und Erweitern gewonnener Kenntnisse führt zum Ziel.

2-19-74

ABKUERZUNGEN - ABBREVIATIONS

acoust	Akustik
adj	Adjektiv
adv	Adverb
aero	Aeronautik
agric	Landwirtschaft
arch	Architektur
astr	Astronomie
bot	Botanik
build	Bautechnik
chem	Chemie
colloq	Umgangsprache
comm	Handelstechnik
comput	Rechenmaschinen
constr	Konstruktion
el	Elektrizität
electron	Elektronik
eng	Ingenieurwesen
f	Femininum
fig	figürlich
gen	allgemein
geogr	Geographie
geol	Geologie
geom	Geometrie
hydr	Hydraulik
i.e.	d.h. (das heisst)
impl	Geräte
instr	Instrumentierung
lab	Laboratorium
leg	Recht, Jura
m	Maskulinum
mach	Maschinen
magn	Magnetismus
math	Mathematik
mech	Mechanik
n	Neutrum
opt	Optik
phys	Physik
plast	Kunststoffe
prep	Präposition
railw	Eisenbahntechnik
s	siehe
statist	Statistik
tech	technisch
telecomm	Fernmeldewesen
telev	Fernsehen
text	Textilindustrie
th dyn	Thermodynamik
top	Topographie
transm	Uebertragung
transp	Transport
zool	Zoologie

INHALTSVERZEICHNIS

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Lesson One

MATHEMATICS I (Arithmetic, Algebra)

Mathematics - a Language. The study of mathematics may be likened to the study of a language. In fact, mathematics is a language, the language of number and size. Just as the rules of grammar must be studied in order to master English, so must certain concepts, definitions, rules, terms, and words be learned in the pursuit of mathematical knowledge. These form the vocabulary or structure of the language. The more a language is studied and used, the greater becomes the vocabulary; the more mathematics is studied and applied, the greater becomes its usefulness.

There is one marked difference, however, between the study of a language and the study of mathematics. A language is based on words, phrases, expressions, and usages that have been brought together through the ages in haphazard fashion according to the customs of the times. Mathematics is built upon the firm foundation of sound logic and orderly reasoning and progresses smoothly, step by step, from the simplest numerical processes to the most complicated and advanced applications, each step along the way resting squarely upon those which have gone before. This makes mathematics the fascinating subject that it is.

As the builder works with his square and compasses, so does the engineer employ mathematics. A thorough grounding in this subject is essential to proficiency in any of the numerous branches of engineering.

Mathematics - a Teacher. In addition to laying a foundation for technical knowledge and assisting in the practical application of knowledge already possessed, mathematics offers unlimited advantages in respect to mental training.

The solution of a problem, no matter how simple, demands logical thinking for it to be possible to state the facts of the problem in mathematical terms and then proceed with the solution. Continued study in this orderly manner will increase the mental capacity of the student, enabling him to solve more difficult problems, to understand more complicated engineering principles, and to cope more successfully with the everyday problems of life.

First, a problem should be analyzed in order to determine the best method of solution. The problem should then be stated in mathematical terms, the principles that are applicable being utilized. If but little progress is made, it is probable the student has not completely mastered the principles explained in the text, and a review is in order. Proficiency in mathematics depends upon thorough understanding of each step as it is encountered, so that it can be used to master that which follows.

Let us first turn our attention to fractions. You have surely met the expressions "half" and "quarter", which are used when the denominator of the fraction equals 2 or 4. 1/3 was originally read "one third part of" but we no longer use the whole phrase and say only "one third". Thus we read 1/5 as one fifth, 1/10 as one tenth etc. Similarly 4/6, 8/10 are read as four sixths, eight tenths. However, if the fraction is not a common one,e. g. $\frac{207}{401}$, then we say "two hundred and seven over four hundred and one".

Next, let us examine decimal fractions. 10.65 is read ten - point - six - five. When the decimal fraction is smaller than one, for instance, 0.76 we read it "point - seven - six". .0006 is read "point - three 0's - six" or less usually "point - nought - nought - nought - six".

Now for algebraical expressions. Fractions are again read "over". $\frac{3a - 1}{ax + b}$ is read "three a minus one over ax plus b". Brackets are indicated by the word "into", e. g. $(a + b)(a - b)$ is read "a plus b into a minus b". Powers are indicated by indices or exponents. The index 2 is read "squared" and the index 3 "cubed", or "to the third". Other indices are read "to the fourth, to the fifth, to the nth.

It is easy to solve linear and quadratic equations; cubic and quartic equations are a little more difficult, whilst no general solution of equations of a higher degree is possible. The roots of an equation may be real or imaginary. If they are real, they may be positive, negative or equal to zero and rational or irrational. One of the most important theorems in Algebra is the Binomial Theorem. The Infinitesimal Calculus, consisting of the differential and the integral calculus, is nearly always called briefly "the Calculus".

Some of the other branches of mathematics are Vector Analysis, Statistics, the Calculus of Variations, etc.

Percentage is merely a kind of fraction or rather, a particular kind of decimal fraction, of which the denominator is always 100. Instead of writing the denominator, we use the term "per cent" to indicate that the denominator is 100. When we speak of "7 per cent" we mean 7/100 or .07. These all mean the same thing, namely, 7 parts out of 100. Instead of writing out the words "per cent" we more often use the sign % after the number, as for instance 7 %, which means "7 per cent". To find a certain per cent of anything, we multiply exactly as we would in finding a fractional part or decimal part of anything. The only difference is that before multiplying we must first change the per cent to its corresponding fraction or decimal.

QUESTIONS

1) What does this lesson deal with?

2) What is the difference between the study of a language and the study of mathematics?

3) What is a language based on?

4) Upon what is mathematics built?

5) What use is mathematics to the engineer?

6) What does mathematics offer?

7) How many kilometres does one mile equal?

8) Who introduced degrees centigrade?

9) What is the difference between a rectangle and a square?

10) What is the shortest distance between two points?

11) Is Euclidean geometry useful?

12) What do we call two angles whose sum is 90°?

13) What is the difference between an acute angle and an obtuse angle?

14) Can a right-angled triangle be equilateral?

15) Who said: "The square on the hypotenuse of a right-angled triangle equals the sum of the squares on the other two sides"?

IMPORTANT TERMS

abscissa (æb'sisə)	Abszisse f
acute (ə'kju:t)	spitzwinklig, spitz
aggregate ('ægrigit)	Summe f; Aggregat n, Gerät n
algebra ('ældʒibrə)	Algebra f
angle ('æŋgl)	Winkel m
area ('ɛəriə)	Fläche f, Flächenraum m
arithmetic	Arithmetik f, Rechnen n
binomial theorem (bai'nəumjəl 'θiərəm)	Binomischer (Lehr)Satz, Binomialsatz (m)
blueprint	Blaudruck m, Blaupause f
bracket	Klammer f (eckig)
calculus ('kælkjuləs)	Kalkül n, Rechnung f
centigrade (scale) ('sentigreid)	hundertteilig, hundertgradig, Celsiusskala f
circle ('sə:kl)	Kreis m, Zirkel m
circumference (sə'kʌm fərəns)	Umkreis m, Peripherie f, Umfang m
common	gewöhnlich, allgemein, gemeinschaftlich
compasses ('kʌmpəsiz) oft: pair of compasses	(Einsatz) Zirkel m
cone	Kegel m, Konus m
converge, to	konvergieren, zusammenlaufen
co-ordinate (kəu'ɔ:dnit)	Koordinate f; koordiniert, gleichrangig
cube, to	in die dritte Potenz erheben, kubieren

curve (kə:v)	Kurve f, Kurvenlineal n
cylinder	Zylinder m, Trommel f, Walze f
dawn (dɔ:n)	Morgengrauen n
denominator	Nenner m
derivative (di'rivətiv)	Derivierte f, abgeleitete Funktion, Differentialquotient m
differentiation (,difərenʃi'eiʃən)	Differentiation f, Ableitung f
digit ('didʒit)	Zahl f, Ziffer f, Ziffernstelle f, Nummer f
ellipse (i'lips)	Ellipse f
equal, to	gleichen, gleich sein
equation (i'kweiʒən, i'kweiʃən)	Gleichung f
equilateral ('i:kwi'lætərəl)	gleichseitig
even	gerade, geradzahlig
finite ('fainait)	endlich, begrenzt
fraction	Bruch m
front elevation	Vorderansicht f, Stirnansicht f
geometry (dʒi'ɔmitri)	Geometrie f
hyperbola (hai'pə:bələ)	Hyperbel f
identity (ai'dentiti)	Identität f, Einheitselement n, Einheitsoperator m
infinite ('infinit, 'in,fainait)	unendlich, unbegrenzt
infinity (in'finiti)	Unendlichkeit f, unendliche Zahl
integral ('intigrəl)	Integral n
intersect, to (,intə(:)'sekt)	sich schneiden, überschneiden, duchdringen
isosceles (ai'sɔsili:z)	gleichschenklig
machine drawing	Maschinenzeichnung f
mathematics (,mæθi'mætiks)	Mathematik f

numerator	Zähler m (eines Bruches)
obtuse (əb'tju:s)	stumpf
obtuse - angled	stumpfwink(e)lig
odd	ungerade, unpaarig
ordinate ('ɔ:dnit)	Ordinate f
parabola (pə'ræbələ)	Parabel f
parallelogram (,pærə'leləugræm)	Parallelogramm n
perpendicular (,pə:pən'dikjulə)	Senkrechte f, Normale f, Lot n
to drop a perpendicular to a line	auf eine Gerade das Lot fällen
plane	Ebene f, ebene Fläche; Hobel m
power	Potenz f; Leistung f, nutzbare Energie, Kraft f; Leistungsvermögen n
power series	Potenzreihe f
prism	Prisma n
quadrilateral	vierseitig, viereckig
quartic ('kwɔ:tik)	Gleichung f vierten Grades, Kurve f vierten Grades; vierten Grades
rectangle	Rechteck n
right-angled	rechtwinklig
satisfy, to	genügen (Bedingung)
set	Menge f (Math.); Aggregat n, Gerät n
side elevation	Seitenriss m
sphere	Kugel f, Globus m, Sphäre f, Bereich m
square	Quadrat n, Vierkant m, Anschlagwinkel m (Zeichengerät); (rechteckiger) Platz
straight line	Gerade f
theorem	Satz m, Lehrsatz m
triangle	Dreieck n, Zeichendreieck n, Winkel m, Triangel m

GRAMMAR AND NOTES

Some English Mathematical Expressions:

x^2 is read: x squared (read: eks skweəd)

x^3 " " : x cubed (kjuːbd); x to the third power

x^4 " " : x to the fourth (power)

x^5 " " : x to the fifth (power)

x^6 " " : x to the sixth (power)

x^7 " " : x to the seventh etc.

x^n " " : x to the nth power or: x to the power n or: x raised to n or: x to the power of n

x^o " " : x to the power of zero

x^{-1} " " : x to the power of minus one (read: mainəs)

x^{-2} " " : x to the power of minus two

x^1 " " : x to the power of one

$\sqrt[2]{x}$ " " : square root of x (read: skwɛə ruːt)

$\sqrt[3]{x}$ " " : cube root of x (read: kjuːb ruːt)

$\sqrt[4]{x}$ " " : fourth root of x

$[a + b]^2$ " " : a plus b in brackets squared or: a plus b all squared

$\frac{dy}{dx}$	is read: dy over dx or: dy by dx (read: di: wai...)
a_b^2	is read: square of a sub b
a/b	is read: a slant b; a stroke b; a slash b
$R_t = \frac{u_t \quad U^2 \quad 10^4}{S_n}$	is read: capital r sub (small) t equals small u sub t times capital u squared times ten to the fourth, all over capital s sub (small) n
	Bemerkung: capital (letter) = grosser Buchstabe; U.S. big letter
$\int_{x_a}^{x_b} \frac{I_p^{\;3}}{p + I_n^{-3}} dx$	is read: integral between the limits x sub a and x sub b of I sub p cubed over p plus I sub n to the minus three times dx
	Pronounce: ('intigrəl).
$\lambda\,(m^2 - n^2)$	is read: lambda ('læmdə) into m squared minus n squared
∞	is read: infinity (in'finiti)
dx	is read: differential (ˌdifə'renʃəl) of x
f (x)	is read: function ('fʌŋkʃən) of x
log x	is read: log or logarithm ('logəriθm) of x
$\log_{10} x$	is read: log of x to the base (beis) 10
$\int_a^b f\,(x)\,dx$	is read: integral of f (x) dx between the limits a and b
$\int_a^b xdx$	is read: the integral from a to b of xdx

see p.467

1. Das Verb im Singular haben die Namen der Wissenschaften auf -ics wie:

mathematics	die Mathematik
mechanics	die Mechanik
physics	die Physik
phonetics	die Phonetik
politics	die Politik
Dazu gehört noch: news	Nachricht(en), Neuigkeit(en)

Wenn es sich jedoch um die praktische Anwendung einer Wissenschaft oder um eine (sportliche) Betätigung handelt (gymnastics, athletics), so werden die Substantive auf -ics als Plural verwendet, z. B.:

What are his tactics?

2. Nur im Singular werden im allgemeinen gebraucht:

a)	knowledge	Kenntnis(se)
b)	advice	Rat, Ratschläge
	information	Auskunft, Auskünfte
	work	Arbeit(en)
	furniture	Möbel, Hausrat
c)	produce	Erzeugnis(se)
	strength	Kraft, Kräfte, Stärke
	progress	Fortschritt(e)
	merchandise	Handelsware(n)
	remorse	Gewissensbisse

Auch die Setzung des unbestimmten Artikels ist hier meist nicht möglich; nur knowledge bildet eine Ausnahme:

She has a good knowledge of the English language

In den Fällen unter b) kann eine entsprechende Vereinzelung durch a piece of ... vorgenommen werden, z. B.:

That's a useful piece of information - Das ist eine brauchbare Information

Mit abgeänderter konkreter Bedeutung kann work = "Werk" den Plural bilden, z. B.:

the works of Shakespeare
works of art - "Kunstwerke"

Ebenso kann advices als "Mitteilungen, Meldungen", kaufmännisch als "Lieferungsanzeige" gebraucht werden.

Als Stoff- bzw. Sammelnamen stehen business, coal, fish, fruit, hair in der Regel im Singular. Die Pluralformen werden meist mit veränderter Bedeutung verwendet, z. B.:

coals = "Kohlenstücke, (Brikett-)Kohlen";
to carry coals to Newcastle = etwas Ueberflüssiges tun
fruits = a) "Obstsorten"
b) "Früchte" in allgemeiner und übertragener Bedeutung, z. B.: the fruits of labour = die Früchte (= der Lohn) der Arbeit;
hairs = (einzelne) Haare; vgl. z. B.: to split hairs = Haare spalten (= übergenau sein).
businesses = shops ("Läden, Geschäfte").

3. Verb und Pronomen im Singular oder Plural haben:

means	(Hilfs-)Mittel
works	Fabrik, Werk
headquarters	Hauptquartier
the United States (the U.S.A.)	die Vereinigten Staaten

The iron works is (or: are) near the station = Das Eisenwerk ist in der Nähe des Bahnhofs.

The United States is (or: are) a big country = Die Vereinigten Staaten sind ein grosses Land.

4. Eine Reihe von Substantiven wird vorwiegend in der Pluralform gebraucht, daneben aber auch (oft ohne Bedeutungsunterschied) im Singular, z. B.:

contents (content)	Inhalt
wages (wage)	Lohn
ashes (ash)	Asche
arms (arm)	Waffen (Waffe)

5. In verschiedenen Fällen wird ein Einheitsplural mit besonderer Bedeutung verwendet, während der daneben bestehende einfache Plural in der Bedeutung mit dem Singular übereinstimmt:

	Bedeutung im Singular und einfachen Plural	Als Einheitsplural
compass(es)	Kompass	Zirkel (a pair of compasses)
custom(s)	Brauch, Gewohnheit	Zoll (a Customs officer)
letter(s)	Brief, Buchstabe	Literatur
picture(s)	Bild	Kino
quarter(s)	Viertel	Quartier
scale(s)	(Waag-) Schale	Waage (a pair of scales)
stair(s)	Stufe	Treppe
step(s)	Stufe	Stehleiter

6. Neutraler Plural (gleiche Form für Singular und Plural)

Bei einer Reihe von Substantiven wird die Singularform entweder stets oder nur in bestimmten Konstruktionen für Singular und Plural verwendet.

Aehnlich wie im Deutschen stehen gewisse Mengen- und Massangaben wie dozen (Dutzend), gross (12 dozen), head ("Stück"), score (= 20), stone (14 pounds) nach Grundzahlen und nach several, a few, how many in der Singularform.

Die Wertbezeichnung pound und das Längenmass foot können nach Grundzahlen ebenfalls im Singular stehen, wenn ihnen eine weitere Zahlenangabe (shillings oder inches) folgt oder wenn sie attributiv gebraucht sind, z. B.:

five pound ten	5 Pfund und 10 Schillinge
a five - pound note	ein Fünf-Pfundschein

In attributiver Verwendung nach Grundzahlen kann die Singularform (meist neben der Pluralform mit oder ohne Apostroph) auch bei anderen Substantiven gebraucht werden:

an eight - hour day	ein Achtstundentag
neben: a three - hours (') journey	eine dreistündige Reise

Die Namen einiger Tiere, besonders die von Fischen, haben stets die Singularform:

deer	Rotwild
sheep	Schaf(e)
pike	Hecht(e)
trout	Forelle(n)

In militärischer oder seemännischer Bedeutung findet sich nur die Singularform bei den Wörtern wie z. B.:

aircraft	Flugzeug(e)
craft	Wasserfahrzeug(e)

Auch die Völkernamen auf - se, - ss haben keine besondere Pluralform:

Japanese	Japaner
Chinese	Chinese(n)
Swiss	Schweizer

Ohne Numerusunterscheidung bleiben auch die aus dem Lateinischen entlehnten Wörter:

series	Serie(n), Reihe(n)
species	Art(en)

Auch manner in "all manner of ..." = "allerlei" sowie umgangssprachlich kind (of) und sort (of) werden ohne Pluralendung verwendet, z. B.:

All manner of colours	alle Arten von Farben

EXERCISES

1. Give the opposite of: Continuous, rational, finite, zero, definite, differentiation, derivative, single - valued, plus, bounded, sum, upper limit, negative, addition, multiplication, acceleration, numerator, independent variable.

2. Put into the Passive Voice: The student was solving the equation. She is integrating it by parts. We are revising the lesson. The draughtsman is drawing the side elevation. We are doing the second exercise. They were expanding the series. The engineer is measuring the area. They are building many houses. At 12 o'clock,she was still differentiating the function. We cannot rely on an old motor. He cannot speak about such things. Gravity acts on mass. The spring presses on the lever. People laughed at Galileo.

3. Translate into English: 1) Zwei Drittel, drei Viertel, vier Fünftel, fünf Sechstel, acht Zehntel. 2) Der Motor hat ungenügende Leistung. 3) Der Anlasser läuft nicht. 4) Ueber dieses Problem wurde nicht gesprochen. 5) Man sprach über Geometrie. 6) Techniker sollten alle wichtigen mathematischen Formeln beherrschen. 7) Statistik ist eines der wichtigsten Gebiete in der Mathematik. 8) Bei uns werden viele Häuser gebaut. 9) Die Entfernung wurde eben gemessen. 10) Was gibt es Neues? 11) Die Vereinigten Staaten sind ein grosses Land. 12) Die Glasfabrik ist in der Nähe des Bahnhofs. 13) Was für eine Taktik will er einschlagen? 14) Zwei Pfund sind (oder: ist) keine grosse Summe. 15) Es gibt kein anderes Mittel. 16) Er liess sich das Haar (oder: die Haare) schneiden. 17) Essen Sie viel Obst? 18) Können Sie mir hierüber Auskunft geben?

21-A

MATHEMATICS II (Geometry, Trigonometry)

Definitions

Geometry treats of the properties, construction, and measurements of lines, surfaces, and solids.

A solid has three dimensions, usually designated as length, breadth, and thickness.

A surface has but two dimensions —length and breadth.

A line has but one dimension — length.

A point has no dimension but is simply a position in space.

Parallel lines are lines that are everywhere equally distant from each other.

A horizontal line is a line parallel to the horizon, or water level.

A vertical line is a line straight up and down.

A line is perpendicular to another when it meets or crosses the other line squarely. Such lines are also said to meet or cross at right angles.

Angles. — An angle is formed by the meeting or intersection of two straight lines. An angle is measured by the difference in direction of the two lines which form the angle. The point of the angle where the lines meet is called the vertex.

A right angle is the angle formed by two lines that are perpendicular to each other. An angle less than a right angle is called an *acute* angle. An angle greater than a right angle is called an *obtuse* angle.

A *circle* is a flat surface bounded by a curved line, all points of which are equidistant from a point within called the *centre*. The bounding line of a circle is called the *circumference*. A straight line drawn from the centre to the circumference is called the *radius*. A straight line through the centre, terminating at both ends on the circumference, is called the *diameter*. The diameter of a circle is equal to twice the radius. The circumference of a circle is equal to 3.1416 times the diameter.

An arc of a circle is any portion of a circumference.

A chord of a circle is a straight line connecting any two points on the circumference.

Circular arcs are measured in *degrees*, there being 360 degrees in a complete circumference. For finer measurements, degrees are divided into *minutes*, and minutes into *seconds*, there being 60 seconds in 1 minute and 60 minutes in 1 degree. Degrees are marked by the sign (°), minutes by ('), and seconds by (").

The complement of an angle is the difference between that angle and 90°. Hence, two angles are said to be *complementary angles* when their sum is 90° or a right angle.

The supplement of an angle is the difference between that angle and 180°.

Polygons. — A plane figure bounded by any number of straight lines can be given the general name of sides. A three-sided figure is called a *triangle*, a four-sided figure, a *quadrilateral*, a five-sided figure, a *pentagon*, etc.

A triangle is a geometrical figure having three angles and three sides. There are several special forms of triangles.

The right triangle, or right-angled triangle, has two of its sides meeting at right angles. The side opposite the right angle is called the hypotenuse. The relation between its sides gives us one of the most useful laws of mathematics, namely,

the square of the hypotenuse is equal to the sum of the squares of the other two sides.

If all of the angles of a triangle are acute angles, the triangle is called an acute triangle. If one of the angles of a triangle is an obtuse angle, the triangle is called an obtuse triangle. When a triangle has two of its sides equal, the triangle is called an isosceles triangle. The angles opposite these sides are also equal. When a triangle has all three sides equal, the triangle is called an equilateral triangle. The three angles are also equal.

The best known quadrilateral or four-sided figure is the square, which has all four sides equal and all of the angles right angles.

The rectangle is any four-sided plane figure with four right angles.

The parallelogram is a plane figure with four sides, having the opposite sides parallel and equal.

The trapezoid (or trapezium) is a quadrilateral with only two sides parallel.

The circle is a plane figure bounded by a single curved line, every point of which is equally distant from the point at the center of the figure. There is a set of important curves whose shape can be obtained by cutting a cone at different angles. Hence the name conic sections. They include the parabola, hyperbola and ellipse, of which the circle is a special case.

The ellipse is a curved figure which may be defined very briefly as a flattened circle.

The parabola is a plane curve which is the path, or locus, of a moving point that remains equally distant from a fixed point (focus) and from a fixed straight line (directrix).

The prism is a solid figure whose ends are parallel, polygonal, and equal in size and shape, and whose sides are parallelograms.

The cube is a solid with six equal, square sides.

The cylinder is a solid figure described by the edge of a rectangle rotated around the parallel edge as axis: the ends of a cylinder are parallel and equal circles.

The pyramid is a solid figure having a polygonal base, the sides of which form the bases of triangular surfaces meeting at a common vertex.

The cone is a solid described by the hypotenuse of a right triangle rotated about either of its legs as an axis.

The sphere is any round body or figure having the surface equally distant from the center at all points:

Cartesian coordinates are 1) a pair of numbers which locate a point by indicating its distance from a fixed pair of lines intersecting one another at right angles: each distance is measured parallel to the other fixed line. 2) a triad of numbers which locate a point by its distance from three fixed planes that intersect one another at right angles.

Polar coordinates : either of two numbers that locate a point in a plane. One is the distance of the point from a fixed point on a fixed line, and the other is the angle made by the fixed line with the line connecting the two points.

TRIGONOMETRY

Trigonometry is a branch of mathematics that deals with the angles and sides of triangles and their relations to one another. It is especially useful in numerous calculations connected with accurate machine work. It is almost invaluable to the surveyor, the draughtsman, and, in fact, is used in all sorts of engineering work.

Trigonometry is based on certain "functions" of angles. A function is a quantity that depends on another quantity for its value. Any quantity that depends upon an angle for its value is a function of that angle. If a right triangle is constructed, having a certain angle at one corner, there will be certain definite relations between the sides of this triangle.

These ratios are six in number and are called the trigonometric functions. The ratio of the opposite side to the adjacent side is called the tangent of the angle. The ratio of the adjacent side to the opposite side is called the cotangent. In any right triangle, the sine of either acute angle is the ratio of the side opposite the angle to the hypotenuse. In any right triangle the cosine of either acute angle is the ratio of the adjacent side to the hypotenuse. The secant of an angle is the reciprocal of the cosine. In a right triangle, the secant of an angle is the ratio of the hypotenuse to the side adjacent to the angle. The cosecant is the reciprocal of the sine.

Trigonometry can be applied to solving triangles of any shape. By solving a triangle we mean that we have some of the sides and angles given and proceed to calculate the rest.

QUESTIONS

1) What does geometry deal with ?
2) How many dimensions has a solid ? a surface ?
3) What is a horizontal line ? a vertical line ?
4) Is the circle inscribed in a triangle greater or smaller than the circumscribed circle ?
5) How many times can a straight line intersect a conic section ?
6) What is a chord ?
7) What is the complement of an angle ?
8) Are two triangles congruent if two sides and the included angle of one are equal to those of the other ?
9) What is a rectangle similar to ?
10) What do we call conic sections ?
11) What is the difference between a cylinder and a prism ?
12) What does trigonometry treat of ?
13) What do we mean by solving a triangle ?

IMPORTANT TERMS

acute angle	(əˈkjuːt ˈæŋgl)	- spitzer Winkel
altitude		- Höhe f
arc		- Bogen m, Kreisbogen m; (el) Lichtbogen m
Cartesian co-ordinates pl	(kaːˈtiːzðn ..)	- Kartesische o. rechtwinklige Koordinaten f/pl
chord	(kɔːd)	- Sehne f; (mus) Saite f
complementary angle		- Ergänzungswinkel m, Komplementärwinkel m
congruent		- (math) kongruent, deckungsgleich
cosecant	(ˈkəuˈsiːkənt)	- Kosekans m, Kosekante f
cosine	(ˈkəusain)	- Kosinus m
cotangent	(ˈkəuˈtændʒənt)	- Kotangens m
cube		- Würfel m ; (math) dritte Potenz, Kubikzahl f, Kubus m
diameter	(daiˈæmitə)	- Durchmesser m, Diameter m
directrix pl. directrixes o. directrices	(diˈrektriks) (diːrektˈtraisiːz)	- Direktrix f, Leitlinie f

flattened ('flætnd)	- abgeplattet, abgeflacht, flachgedrückt
hypotenuse (hai'pɔtinjuːz)	- Hypotenuse f
included angle	- eingeschlossener Winkel
mark off, to	- abgrenzen, abstecken; (math.) ab-, auftragen
oblique (ə'bliːk)	- schräg; (math.) schief, schiefwinklig; (print) Schrägschrift f
obtuse angle (əb'tjuːs ··)	- stumpfer Winkel
pentagon ('pentəgən)	- Fünfeck n, Pentagon n
perimeter (pə'rimitə)	- Umkreis m, Umfang m, Peripherie f
polar coordinates	- Polarkoordinaten f / pl
polygon ('pəligən)	- Vieleck n, Polygon n
pyramid ('pirəmid)	- Pyramide f
radius ('reidjəs)	- Umkreis m; (math.) Halbmesser m, Radius m
rhombus ('rəmbəs)	- Rautenfläche f , Rhombus m
ruled surface	- Regelfläche f, durch eine Gerade erzeugte Fläche
scroll	- (math.) schiefe Ebene (skew surface) (skjuː ···)
secant ('siːkənt)	- Sekante f
sector	- Sektor m, Gebiet n, Bereich m
segment	- Abschnitt m, Segment n ; (el) Lamelle f
shape	- Form f , Gestalt f
sine (sain)	- Sinus m
solid ('səlid)	- Festkörper m, fester Körper
supplement (of an angle)	- Ergänzung , Ergänzungswinkel m, Supplement n
tangent ('tændʒənt)	- Tangente f
trapezoid ('træpizɔid)	- beliebiges Viereck; Trapez n
trigonometry (ˌtrigə'nɔmitri)	- Trigonometrie f
vertex, pl. vertices o.vertexes ('vəːteks, -isiːz, -eksiz)	- Scheitelpunkt m, Spitze f , Zenit m, Vertex m

GRAMMAR and NOTES

1. A line has but one dimension - length

But als Adverb mit der Bedeutung a): nur, bloss, lediglich

Andere Beispiele: He is but a student - er ist nur ein Student;
there is but one way out - es gibt nur einen Ausweg

b): erst, gerade,

z.B.: but last week - erst letzte Woche

c): all but - fast, beinahe, nahezu,

z.B. he was all but drowned - er wäre fast ertrunken

2. Two angles are said to be complementary angles when their sum is 90° or a right angle.

A circuit is said to have a self - inductance of 1 henry when a counter-electromotive force of 1 volt is generated by a rate of change of current of 1 ampere per second.

He is said to be a clever engineer - Man sagt von ihm, er sei ein kluger Techniker. Er soll ein kluger Techniker sein.

Die Passivkonstruktion hat auch das Verb to say (to be said to....), das im Aktiv den Objektskasus und Infinitiv nicht zulässt.

3. Die Schreibweise der Zahlenwerte. Im allgemeinen sollte ein Zwischenraum gesetzt werden, um Zahlengruppen klar darzustellen. Grössere Zahlenwerte sollten vom Dezimalpunkt nach links mit einem Zwischenraum in Dreiergruppen abgetrennt werden.

Beispiele: 10 000
134 658
2 126 793

Hingegen ist bei vierstelligen Zahlen links vom Dezimalpunkt (Zahlen bis 9999) der Zwischenraum nach drei Stellen nicht nötig.

Im amerikanischen Englisch werden die Hunderter von den Tausendern durch ein Komma getrennt, z.B. : 1,000,000 (a thousand thousands).

Zahlenwerte kleiner als 1 sollten immer mit einer Null und nachfolgendem Dezimalpunkt beginnen und vom Dezimalpunkt nach rechts ebenfalls in Dreiergruppen abgetrennt werden.

Nach der britischen Norm "British Standard 1991: Part 1: 1967" wird das Dezimalzeichen (decimal marker) entweder auf Zeile oder auf halbe Höhe gesetzt, z.B.:

0.239 oder 0·239 nicht .239 oder ·239

Im deutschsprachigen Raum wird bei Dezimalwerten vorzugsweise das Komma benutzt. Die Amerikaner setzen einen Punkt auf Zeile, z.B. 30.7.

Anmerkung:

British Standards Institution (BSI) bemerkt zu diesem Problem: "In general, a space should be used to break extended numbers into groups of three on either side of the decimal marker:

e.g. 10 000
0.023 45

However, with four-figure numbers to the left of the decimal marker, i.e. numbers up to and including 9999, the space is regarded as unnecessary; such numbers are easy to comprehend mentally.

In any case the use of the space is not regarded as mandatory - it is merely recommended as good practice and style to help comprehension of the figures. Sometimes there are over-riding considerations which make the use of the space inconvenient (e.g. tabulated figures without spaces may be available from a computer and it becomes a great nuisance to have to insert the spaces before printing).

What we say above applies to the printing of numerical values in ordinary textual material but not to currency where special rules apply". (Brief vom 30. Januar 1973)

4. Some Signs and Symbols in Geometry

∠, pl. ∠s	angle, as in : ∠ ABC
∟	right angle
⊥, pl. ⊥s	perpendicular; is perpendicular to, as in EF ⊥ MN = EF is perpendicular to MN
∥	parallel, pl. ∥s; is parallel to, as in EF ∥ DG
○	circle; circumference; 360°
⌒	arc of a circle
△	triangle, as in △ ABC
□	square, as in □ ABCD
▭	rectangle
▱	parallelogram
ϕ	diameter
0	ellipse
⌔	sector
⌓	segment
°	degree, degrees
′	minute, minutes
″	second, seconds
≅	is congruent to
∴	therefore; hence
∵	since; because

EXERCISES

1. Form Final Clauses as in the following example:

We work, we earn money. - We work (in order, so as) to earn money.

We use the decimal system, we make calculation easy.

We learn Euclidean geometry, we understand co-ordinate geometry.

She bisected the angle, she proved the theorem.

Two sides and the included angle must be equal, two triangles are congruent

A series must converge quickly, it is useful.

We make things of aluminium, we reduce their weight.

The temperature must be 0° C, water becomes ice.

2. Use infinitives in the following sentences:

They went to the lecture early in order that they might get good seats.

Follow the directions carefully in order that you may avoid unnecessary errors.

She stood up so that she might see better.

I left the letter at home so that she might read it.

This step was taken in order that everyone might be satisfied.

3. Translate into German:

New experiments are suggested for the hypothesis to be tested.

A convenient system of measurement should be decimal for its units to be in harmony with our decimal system of numeration.

The announcement was put up at the entrance for everyone to read it.

A monomial is an algebraic expression whose last operation in point of order is neither addition nor subtraction.

An algebraic expression, which consists of several monomials connected by the + and - signs, is known as a polynomial.

A proper fraction is one whose numerator is less than the denominator.

An improper fraction is one whose numerator is equal to or larger than the denominator.

4. Translate into English:

Heligkeitsmesser ist ein Gerät, welches zur vergleichsweisen Messung der Helligkeit dient.

Elektromechanische Systeme sind Systeme, bei denen mechanische Bewegungen mit elektrischen Vorgängen (und umgekehrt) gekoppelt sind.

Diese Verhältnisse werden im Leistungsdiagramm berücksichtigt, das meist in logarithmischem Masstab ausgeführt ist.

Lesson Three

MATHEMATICS III / The Differential Calculus, The Integral Calculus)

Heraclitus (ˌherəˈklaitəs) said that "everything is in motion", and daily experience teaches us that changes are continually taking place in the properties of bodies around us. Change of position, motion, temperature, volume and chemical composition are only a few of the myriad changes associated with bodies in general.

Higher mathematics, in general, deals with magnitudes which change in a continuous manner. In order to render such a process susceptible to mathematical treatment, the magnitude is supposed to change during a series of very short intervals of time. The shorter the interval the more uniform the process.

An instantaneous velocity is represented by the symbol

$$\frac{d\,x}{d\,t} = V,$$

where dx is the symbol used by mathematicians to represent an infinitely small amount of something, and dt a correspondingly short interval of time. The quotient dx/dt is known as the differential coefficient of x with respect to t. The value of x obviously depends upon what value is assigned to t, the time of observation. For this reason x is called the dependent variable, t the independent variable. The differential coefficient is the only true measure of a velocity at any instant of time.

The term "velocity" not only includes the rate of motion, but also the direction of the motion. The concept velocity need not be associated with bodies. If a quantity of heat is added to a substance at a uniform rate, the quantity of heat, Q, added per degree rise of temperature, θ, corresponds exactly with the idea of a distance traversed per second of time. Specific heat, therefore, may be represented by the differential coefficient $d\,Q/\,d\,\theta$. Similarly, the increase in volume per degree rise of temperature is represented by the differential coefficient $d\,v/\,d\,\theta$; the decrease in volume per unit of pressure, p, is represented by the ratio $-d\,v\,/\,d\,p$, where the negative sign signifies that the volume decreases with increase of pressure. In these examples, it has been assumed that unit mass or unit volume of substance is operated upon, and therefore the differential coefficients respectively represent specific heat, coefficient of expansion, and coefficient of compressibility.

From these and similar illustrations it is evident that the conception called by mathematicians the "differential coefficient" is not new. Everyone uses it whenever a "rate", "speed", or a "velocity" is in question.

DIFFERENTIALS.

It is sometimes convenient to regard d x and d t, or more generally d x and d y, as very small quantities which determine the course of any particular process under investigation. These small magnitudes are called differentials or infinitesimals. Differentials may be treated like ordinary algebraic magnitudes. If $d\,x\,/\,d\,t = V$, we may write in the language of differentials

$$d\,x = V.d\,t$$

THE INTEGRAL CALCULUS

The signs "Σ" and "$\int$" are abbreviations for "the sum of all the terms containing ..."; the subscripts and superscripts denote the limits between which the time has been reckoned. When the limits between the integration are to be performed, are stated, the integral is said to be definite; when the limits are omitted, the integral is said to be indefinite.

The superscript to the symbol "$\int$" is called the *upper* or *superior limit*; the subscript, the *lower* or *inferior limit*.

The operation denoted by the symbol "$\int$" is called *integration*. When this sign is placed before a differential function, say d x, it means that the function is to be integrated with respect to d x. *Integration is essentially a method for obtaining the sum of an infinite number of infinitely small quantities.* The integral itself is not exactly what we usually understand by the term "sum", but it is rather "the limit of a sum when the number of terms is infinitely great."

A differential equation, freed from constants, is the most general way of expressing a natural law. Any equation can be freed from its constants by combining it with the various equations obtained by differentiation of the given equation as many times as there are constants. The operation is called *elimination*. It enables us to discard the accidental features associated with any natural phenomenon and to retain the essential or general characteristics.

We always *assume* that every differential equation has been obtained by the elimination of constants from a given equation called the *primitive.* In practical work we are not so much concerned with the building up of a differential equation by the elimination of constants from the primitive, as with the reverse operation of finding the primitive from which the differential equation has been derived. In other words, we have to find some relation between the variables which will satisfy the differential equation. Given an expression involving $x, y, d x/ d y, d^2 x/ dy^2$, ..., to find an equation containing only x, y and constants which can be reconverted into the original equation by the elimination of the constants.

This relation between the variables and constants, which satisfies the given differential equation, is called a *general solution*, or a *complete solution*, or a complete integral of the differential equation. A solution obtained by giving particular values to the arbitrary constants of the complete solution is a *particular solution.*

A differential equation is ordinary or partial, according to whether there is one or more than one independent variables present. The order of a differential equation is fixed by that of the highest differential coefficient it contains. The degree of a differential equation is the highest power of the highest order of differential coefficient it contains.

QUESTIONS

1) What does this lesson deal with ?
2) What is a dependent variable ?
3) What does the term "velocity" include ?
4) What do we call the "differential coefficient"?
5) What is an integration ?
6) What does elimination enable us ?
7) What is a particular solution ?
8) By what is fixed the order of a differential equation ?
9) What is the degree of a differential equation ?

IMPORTANT TERMS

arbitrary	=	beliebig, willkürlich, nach freiem Ermessen
assign, to (a value to)	=	einen Wert beilegen
compressibility	=	Kompressibilität f, Zusammendrückbarkeit f
differential calculus (ˌdifəˈrenʃəl ···)	=	Differentialrechnung f
differentiation (ˌdifərenʃiˈeiʃən)	=	Ableitung f, Differentiation f, Differenzierung f
discard, to	=	ausscheiden, ausser Gebrauch setzen, weglegen
feature	=	Merkmal n, Eigenschaft f, Besonderheit f
infinitesimal calculus (ˌinfiniˈtesiməl ˈkælkjuləs)	=	Infinitesimalrechnung f
instantaneous (ˌinstənˈteinjəs)	=	augenblicklich, momentan, unverzüglich
integral calculus (ˈintigrəl ··)	=	Integralrechnung f
magnitude	=	Grösse f, Grössenordnung f; Bedeutung f, Umfang m

satisfy, to = befriedigen ; entsprechen, erfüllen (math.)

subscript = Index m, tiefgestellter Index, Tiefzahl f

superscript = oberer Index

susceptible (sə'septəbl) = aufnahmefähig, empfindlich

to be susceptible of (od, to) = zulassen
susceptible of development = entwicklungsfähig

variable = Variable f, Veränderliche f; (adj.): variabel, veränderlich

GRAMMAR and NOTES

1. When the limits between the integration are to be performed, are stated, the integral is said to be definite.

   Die Verbindung to be to + Infinitiv wird im Präsens und Präteritum als modales Hilfsverb in der Bedeutung "sollen" verwendet.

2. Some Signs and Symbols in the Calculus:

$\frac{d}{d}$ derivative, as in: $\frac{d\,y}{d\,x}$ = the derivative of y with respect to x
Δ an increment, as Δy = an increment of y
d differential, as d y = differential y
$\sum^{n}$ sum of n terms
$\sum^{\infty}$ sum of an infinite number of terms
$\prod^{n}$ product of n terms
lim limit, as in: lim (x) = a; y→b; i.e. the limit of x as y approaches b is a
$\int$ integral, as in: $\int f(x)\,d\,x$; i.e. the integral of f (x) with respect to x

EXERCISES

1. Translate into German:

We are to study the motion of a body. The first law explains what is to be understood by "force". When the state or condition of a body is such that it can do work, the body is said to possess energy. To the ordinary observer the air seems to have no weight. The investigation was announced to proceed satisfactorily. The students are expected to possess at least this minimum knowledge of the subject. The author claims to have discovered sufficient proof. Neglect of this factor appears to introduce large errors. The solution obtained cannot be claimed to be the best possible. Such forces are said to be due to electrical charges. On the whole, little attention seems to have been devoted to the problem.

2. Use infinitive as in the following example:

a) We may assume that this is the case. – We may assume this to be the case.

We believe that these measures are sufficient. We expect that the value will vary. We suppose that this attitude has changed. Who has proved that the theory is wrong? We know that he is an efficient engineer. Everyone reported that he was the best teacher.

b) It appears that this interpretation is generally accepted. – This interpretation appears to be generally accepted.

It has been found that this value depends on certain conditions. It seems that there is little doubt about it. It can be easily proved that the rays penetrate black paper. It was supposed that the student knew the rules. It is assumed that such changes occur at high temperatures. It is known that the method was used in the nineteenth century.

3. Translate into English:

Man nennt es auch vollständiges (totales oder exaktes) Differential. Dieses Buch soll in der Praxis tätigen Ingenieuren die wissenschaftlichen Grundlagen der Fernsehtechnik vermitteln. Die Literaturhinweise, die jedem Kapitel zugeordnet sind, sollen den Zugang zur modernen Literatur über Webmaschinen erleichtern. Auf diese Weise kann das Ohmsche Gesetz auch auf komplizierte Schaltungen angewandt werden. Die folgende Zusammenstellung soll einen Begriff von den für industrielle Produktion benötigten Energien geben.

Lesson Four

Elements of Physics

Physics is a broad science that deals primarily with phenomena involving the transformation of matter and energy. Its object is to determine exact relations between physical phenomena so that the sequence of events can be clearly understood and definitely predicted. The boundaries between physics and chemistry are not very definite. There are certain aspects of nature, however, that are primarily the legitimate field of physics. For convenience, they may be grouped under seven headings:

1. *mechanics,*
2. *sound,*
3. *heat,*
4. *electricity and magnetism,*
5. *light and spectroscopy,*
6. *atomic and nuclear physics,*
7. *astrophysics.*

In addition to these seven fields of physics, another field known as

biophysics

is rapidly developing. These different fields are not distinct but merge into each other. In all cases physics deals primarily with phenomena that can be accurately described in terms of matter and energy. Hence, the basic concepts in all physical phenomena are the concepts of matter and energy. It becomes of first importance in physics therefore, *to determine accurately the characteristics of both matter and energy, the laws that govern their transformations, and the fundamental relations that exist between them.*

Statics. *Nature of a Force.*

The word *force* is a general term for any push or pull. A force is always exerted on a body by another body, or on a part of a body by another part. Though a force is really an action of one body on another, it is customary and convenient to speak of the force itself as acting on the body to which it is applied.

A force may act through contact like the pressures of a crankshaft on its bearings,or it may act from a distance like gravitational or magnetic attraction. It may act on or be distributed over a considerable area of contact like the thrust of earth against a retaining wall, or it may act on so small an area as to be practically concentrated at a point like the pressure of a locomotive wheel on a rail.

But whether exerted through contact or from a distance, whether distributed or concentrated, a force is always exerted on something by something.

The gravitational force exerted on a body by the earth acts toward the earth's center; it is a distributed force, acting on all the particles that make up the body, but for many purposes it is convenient and correct to regard it as a concentrated force acting at a point called the center of gravity of the body. The gravitational attraction or earth pull on a body is commonly called the weight of the body.

EQUILIBRIUM of FORCES. TORQUE.

The tendency of a force to produce rotation depends on the magnitude of the force and on the perpendicular distance between the line of action of the force and the axis about which the rotation takes place. It is proportional to the magnitude of the force and also to the distance between the line of action of the force and the axis of rotation. It is convenient to define torque, or moment of force, as the product of the force and the perpendicular distance between the line of action of the force and the axis of rotation.

Torque = force x distance from axis

Center of Gravity. Every particle of a body possesses weight, so that the pull of the earth on the body is made up of a large number of forces directed toward the center of the earth.

Types of Equilibrium. The equilibrium of a body may be stable, unstable or neutral.

Stability of a Body. The position of the center of gravity is of much importance in determining the stability of a body. The lower the center of gravity, the greater the stability of the body and the more difficult it is to overturn. A body becomes unstable as soon as the vertical line through the center of gravity falls outside its base.

QUESTIONS

1) What kinds of equilibrium are there? 2) In what kind of equilibrium is a train standing on a level track? on the top of a hill? 3) What do we call the moment of two parallel equal and opposite forces? 4) On what point of a body do all external forces act? 5) What force acts on a rotating particle? 6) What is the ratio of output to input called? 7) Why can we not reach an efficiency of 100 %? 8) How do we define torque (moment of force)? 9) What does every particle of a body possess? 10) What does physics deal with?

IMPORTANT TERMS

bearing	- (gen) Tragen n, Verhalten n, Stützen n; (mech) Lager n; (constr) Auflager n; (radar) Peilung f; (astr) Abweichung f
boundary	- Begrenzung f, Grenze f, Trennungslinie f; (math) Abgrenzung f
centre of gravity	- Schwerpunkt m
crankshaft	- Kurbelwelle f
equilibrium of forces	- Kräftegleichgewicht n
equilibrium of moments	- Momentausgleich m
gravitation	- Gravitation f, Massenanziehung f, Erdanziehung f, Anziehungskraft f
gravitational force	- Erdanziehungskraft f
moment of force	- Kraftmoment n, statisches Moment
pull	- (gen) Ziehen n, Zerren n, Zug m; (mech) Zugkraft f; (fig) Anziehungskraft f

push - (gen) Stoss m, Stossen n, Schieben n; (constr) horizontaler Druck

push - and - pull - Zug m und Druck m

retaining wall - Stützmauer f; Staumauer f (hydr)

sequence - Folge f, Reihenfolge f

thrust of earth - Erddruck m

torque - Drehmoment n

GRAMMAR AND NOTES

1. The units used .... (= which are used)
   The force referred to .... (= the force which is referred to)
   The molecules forming .... (= which are forming)

   Als erweitertes Attribut steht das Partizip im Sinne eines bestimmenden Relativsatzes hinter dem Subjekt oder (nach einleitendem it is, this / that is) hinter dem Prädikatsnomen.

2. A force may act on or be distributed over a considerable area of contact like the thrust of earth against a retaining wall or ....
   A few electrons may readily be removed from, or added to, an atom ....

   Abweichend vom Deutschen können im Englischen zwei Verben (ebenso wie Adjektive und Substantive) mit verschiedenen Präpositionen ein gemeinsames Objekt haben. In der Schreibung kann die Doppelbeziehung durch Kommasetzung nach beiden Präpositionen verdeutlicht werden.

   Zur genaueren Bestimmung eines (meist räumlichen oder zeitlichen) Verhältnisses können zwei Präpositionen zusammentreten :
   He looked at me from over his glasses.
   Er sah mich über die Brillengläser hinweg an.

3. The position of the center of gravity is of much importance in determining the stability of a body.
When the forces act in the same direction, the resultant is found by adding the applied forces.

In Verbindung mit Präpositionen wird das Gerundium (bzw. Verbalsubstantiv) auch als adverbiale Bestimmung verwendet. Im Deutschen steht in diesen Fällen gewöhnlich ein Nebensatz mit einer entsprechenden Konjunktion. Einer Zeitbestimmung mit ON, AFTER, BEFORE + Gerundium entsprechen im Deutschen temporale Nebensätze mit "als, nachdem, bevor, ehe". Nach after findet sich auch die Perfektform des Gerundiums.

Merke auch: by + Gerundium = deutscher Nebensatz mit "dadurch dass",
for +Gerundium = deutscher Nebensatz mit "dafür dass",
without +Gerundium = deutscher Nebensatz mit "ohne dass".

EXERCISES

1. Use Gerunds with prepositions:
Before he made the experiment, Faraday connected the coils. After he had set up the circuit, he sent a current through it. When he switched off the current, an electromotive force was induced in the secondary winding. We use wire when we make coils. When he carried out this experiment, Faraday discovered electromagnetic induction. Before he works with high tension, he always tests the insulation. When he was asked about the use of his discovery, Faraday answered: "What is the use of a new-born baby ?".

2. Use Gerunds where possible:
I am afraid that I shall disturb her (of). Several workers were criticized because they did not observe the safety rules (for). He complains that the room is very hot (of). I am surprised that she behaves like that (at). She was pleased that her work was appreciated (at). I am sorry that I interfere with his programme (for). We are very sorry that we are lagging behind the other departments (for).

3. Translate into English:
In diesen Bahnen kreist das Elektron, ohne Energie abzustrahlen. Elektronen können auch selbständig (frei) im Raum vorkommen, ohne an ein Atom gebunden zu sein. In der Kinematik behandeln wir die Bewegung eines Körpers, ohne dabei nach den wirksamen Kräften zu fragen. Statt die Akustik selbst regelbar zu machen, kann man durch Aenderung der Lage und der Richteigenschaften der Schallquelle ähnliche Effekte erzielen.

TEMPERATURE EFFECTS

The reason for stating the temperature is that the resistance of all pure metals increases with a rise in temperature. The results of experiments show that over ordinary temperature ranges this variation in resistance is directly proportional to the temperature. Hence, for each degree rise in temperature, above some reference value, each ohm of resistance is increased by a constant amount α, called the temperature coefficient of resistance.

The relation between temperature and resistance may be expressed by the equation

$$R_t = R_o \ (1 + \alpha t) \qquad (7)$$

where R_t = resistance at a temperature of t° C ,
R_o = resistance at 0°C ,
α = temperature coefficient of resistance at 0° C.

The temperature coefficient for copper is 0.00427. That is, if a copper wire has a resistance of 1 ohm at 0° C , it will have a resistance of 1 + 0.00427 ohms at 1° C. The value of the temperature coefficient for copper is essentially the same as that for most of the unalloyed metals.

A more convenient relation is derived by assuming that the proportionality between resistance and temperature extends linearly to the point where copper has a resistance of 0 ohms at a temperature of -234.5° C. This results in the ratio

$$\frac{R_2}{R_1} = \frac{234.5 + t_2}{234.5 + t_1} \qquad (8)$$

where R_1 = resistance of copper in ohms at a temperature of t_1° C.,
R_2 = resistance of copper in ohms at a temperature of t_2° C.

Example 1. The resistance of a coil of copper wire is 34 ohms at 15°C.

What is its resistance at 70°C?

Solution: Given R_1 = 34 ohms, $t_1 = 15^{\circ}$ C, and $t_2 = 70^{\circ}$ C. R_2 = ?

Solving Eq. /8/ for R_2, $$R_2 = \left(\frac{234.5 + t_2}{234.5 + t_1}\right) R_1$$

Substituting the known values,

$$R_2 = \left(\frac{234.5 + 70}{234.5 + 15}\right) \times 34 = 41.5\,\Omega$$

The specifications for electrical machines generally include a provision that the temperature of the coils, etc., when the machines are operating under a specified load for a specified time, must not rise more than a certain number of degrees. The temperature rise may be computed by measuring the resistance of the coils at room temperature and then again at the end of the test.

Problems

1) If the resistance of a copper wire is $8.45\,\Omega$ at 0° C , what will be its resistance at 40° C ?

2) The resistance of the secondary of a transformer is $15.8\,\Omega$ at 20° C. What will be the resistance when the temperature has increased to 80° C?

3) What will be the resistance of the transformer secondary of Prob. 2 at a temperature of -10° C?

4) The resistance of the primary of a transformer was 3.06 Ω at 20° C. After operating for 2 hr the resistance increased to 3.86 Ω. What was the final operating temperature?

5) The specifications for a certain generator included a provision that it was to operate continuously under full load with the temperature of the coils not exceeding 95° C. The resistance of the coils was measured and found to be 84.6 Ω at a temperature of 40° C. After a day's run at full load the machine was shut down and the resistance of the coils measured. Now the resistance was 105 Ω. Did the machine meet the specifications?

QUESTIONS

1) When does the resistance of all pure metals increase? 2) What do experiments show? 3) How does each ohm of resistance increase? 4) What is the temperature coefficient of resistance? 5) How may the relation between temperature and resistance be expressed? 6) What is the temperature coefficient for copper? 7) Define Ohm's law. 8) How does the proportionality between resistance and temperature extend? 9) What do the specifications for electrical machines generally include? 10) How can a temperature rise be computed?

IMPORTANT TERMS

assume, to	annehmen
coil	Spule f, Wicklung f, Windung f (Feder); Rohrschlange f, Schlangenrohr n
coil, to	(auf) wickeln (Feder); aufrollen, spulen, winden
continuous (kən'tinjuəs)	dauernd, ununterbrochen, fortlaufend, kontinuierlich
copper	Kupfer n
increase ('inkri:s)	Anstieg m, Erhöhung f, Steigerung f
increase, to (in'kri:s)	zunehmen, anwachsen, vergrössern; erhöhen (of temperature, prices, etc.)
linear ('liniə)	linear, geradlinig, Linien ...
load (ləud)	Last f, Ladung f, Gewicht n, Belastung f
load, to	belasten, beladen, (auf) laden, pupinisieren (el)
operate, to	betätigen, bedienen, handhaben; operieren
primary ('praiməri)	primär, Primär ...; Primärspule f
provision	Beschaffung f, Besorgung f; Massnahme f
range	Bereich m, Gebiet n, Umfang m; Reichweite f, Entfernung f, Abstand m
range, to	rangieren, gehören (zu), zählen (zu), sich erstrecken, reichen
reference value ('refrəns 'vælju:)	Bezugswert m
rise (raiz)	Anstieg m, Steigen n, Steigerung f (of prices), Erhöhung f (of wages)
rise, to (raiz)	steigern, erhöhen, zunehmen; steigen; aufgehen
secondary ('sekəndəri)	sekundär, Sekundär ...; Sekundärwicklung f (secondary winding)
shut down, to	ausser Betrieb setzen, einstellen, abstellen, absperren; stillsetzen (a reactor)

substitute, to	ersetzen, austauschen, vertreten, substituieren
temperature effect	Einfluss m der Temperatur
unalloyed metal ('ʌnə'lɔid 'metl)	unlegiertes Metall
wire ('waiə)	Draht m, Leitungsdraht m, Leiter m; Telegramm n
wire, to	Drähte verlegen, Leitungen verlegen, (ver) drahten

GRAMMAR AND NOTES

1.

Weitere Unterschiede zwischen der britischen und amerikanischen Sprache.

Die Verdoppelung des Endkonsonanten der Verben, z. B.: travel - travelling, travelled, traveller wird im Amerikanischen nur dann angewandt, wenn die Endsilbe betont ist, z. B.: expel - expelled, expelling. Bei nicht betonten Endsilben tritt keine Verdoppelung ein, z. B.: travel, traveled, traveling.

British	American	German
aerial	antenna	Antenne f
ageing	aging	Altern n, Vergüten n, Tempern n (Metallurgie)
aluminium	aluminum	Aluminium n
autumn	fall	Herbst m
billion (10^{12})	trillion	Billion f
bonnet	hood	Motorhaube f, Kühlerhaube f
chemist's shop	drugstore	Drogerie f
chiropodist	podiatrist	Fusspfleger m, Fusspflegerin f
cupboard	closet	Schrank m, Wandschrank m

draught	draft	Zeichnung f, Skizze f, Entwurf m; Luftzug m, Zugluft f
draughtsman	draftsman	Zeichner m
ensure, to	insure, to	versichern
gauge	gage	Messer m, Messgerät n, Lehre f
gauge, to	gage, to	messen, abmessen, ausmessen, eichen, kalibrieren
gramophone	phonograph	Plattenspieler m
jib (of crane)	boom	Ausleger m
lift	elevator	Aufzug m
lorry	truck	Lastwagen m
manoeuvre	maneuver	Manöver n,
metre	meter	Meter n
milliard (10^9)	billion	Milliarde f
mitre	miter	Fuge f, Gefüge n, Gehrung f
mould	mold	Gestalt f, Form f, Matrize f
petrol	gasoline, gas	Benzin n, Kraftstoff m
plumber	tinner, tinman	Klempner m, Spengler m, Blechschmied m
programme	program	Programm n
railway	railroad	Eisenbahn f
saloon (car)	sedan	Limousine f
shop	store	Laden m, Geschäft n
silencer	muffler	Schalldämpfer m, Auspufftopf m
sleeper	tie	Eisenbahnschwelle f Schienenschwelle f
solicitor	attorney	Anwalt m, Rechtsanwalt m
spanner	wrench	Schraubenschlüssel m, Sechskantschlüssel m
station car	station wagon	Kombiwagen m,
sump	pan	Oelwanne f

tap	faucet	(Wasser)hahn m, Zapfen m
tarmac	ramp	Flugzeugparkplatz m, Hallenvorfeld n
tin	can	Büchse f, Konservendose f
tram, tramway, tramcar	street-car, streetcar	Strassenbahn f
trunk line	long-distance line	Fernleitung f
tyre	tire	Reifen m, Mantel m
underground, tube (colloq.), underground railway	subway	Untergrundbahn f, U-Bahn f
valve	tube	(Elektronen)röhre f
warehouse	department store	Warenhaus n
windscreen	windshield	Windschutzscheibe f
wireless	radio	Radio n, Funk m, Rundfunk m

2. Every - each

Zur Bezeichnung einer Gesamtheit steht Every = "jeder, alle" nur attributiv, meist als Singular zu all:

With every good wish for a Happy New Year
Mit allen guten Wünschen für ein glückliches Neues Jahr

every three days	alle drei Tage
each = "jeder (einzelne)"	attributiv und substantivisch
each ohm of resistance ...	Jedes Ohm des Widerstandes ...
on each page	auf jeder (einzelnen) Seite

Nachgestellt wird each in Verbindung mit Grundzahlen im Sinne von "je" gebraucht:

They cost one shilling each
Sie kosten je einen Schilling

3. Gesamtvorstellungen ohne Artikel

Abstrakta, Sammelnamen, Stoffnamen und Gattungsnamen im Plural haben sinngemäss keinen Artikel, wenn sie ohne Einschränkung verwendet werden:

I. Abstrakta

a)

work	die Arbeit
nature	die Natur
culture	die Kultur
art	die Kunst
life	das Leben
science	die Wissenschaft
literature	die Literatur
history	die Geschichte
peace	der Friede u. a.

He studies history	Er studiert Geschichte
He is especially good in (at) history	Er ist besonders gut in Geschichte

Ebenso werden attributive Fügungen oft als nicht-eingeschränkte Gesamtvorstellungen empfunden und daher ohne Artikel gebraucht, z. B.:

nature study	das Naturstudium
motor traffic	der Autoverkehr
public opinion	die öffentliche Meinung
English literature	die englische Literatur

b) Verbalsubstantive auf -ing ohne of- Ergänzung, z. B.:

Do you like painting?	Macht Ihnen (das) Malen Spass?
Do you object to smoking?	Haben Sie etwas gegen das Rauchen?

c) in übertragener Bedeutung Substantive wie

school	der Unterricht

business	das Geschäft(sleben)
prison	die Haft
church, chapel	der Gottesdienst
in business (prison, church)	im Geschäftsleben (in der Haft, im Gottesdienst)
at (or:in) school	in der Schule
after school	nach der Schule

Bei konkreter Bedeutung, d. h. für das Gebäude oder die Institution (= alle Angehörigen) steht dagegen der Artikel:

The school will have a holiday tomorrow
Die Schule hat morgen einen freien Tag

They visited the church and the school
Sie besichtigten die Kirche und die Schule

Das gleiche gilt für college, hospital, bed und - dem Deutschen entsprechend - für court und table, z. B.:

He is going back to college tomorrow
Er fährt morgen zur Hochschule zurück

in bed; at table	im Bett; bei Tisch
to bring (or: take) to court	vor Gericht bringen

Aber: The court found him not guilty
Das Gericht befand ihn für unschuldig

We were sitting at the table
Wir sassen am Tisch

II. gewisse Sammelnamen (Kollektiva) wie

money	das Geld
hair	das Haar, die Haare

mankind	die Menschheit
Labour	die Arbeiter(schaft)
Capital	das Kapital, die Kapitalisten

ähnlich die Wortbildungen auf - ism:

Capitalism	('kæpitəlizəm)	der Kapitalismus
Socialism	('səuʃəlizəm)	der Sozialismus
Marxism	('ma:ksizəm)	der Marxismus
Communism	('kɔmjunizəm)	der Kommunismus

Bemerkung: Mit dem Artikel werden dagegen gebraucht:

the public	das Publikum, die Oeffentlichkeit
the peasantry	die Bauern(schaft)
the bourgeoisie (,buəʒwa:'zi:)	die Bourgeoisie
the gentry	der Landadel
the nobility	der (Hoch-) Adel

III. Stoffnamen (wie auch im Deutschen)
wie:

coal	die Kohle
iron	das Eisen
wood	das Holz
copper	das Kupfer u. a.

Iron is more useful than gold
(Das) Eisen ist nützlicher als (das) Gold

The export of coal — der Kohle(n)export

aber: the coal that is exported
Die Kohle, die exportiert wird

Substantive, die bei uneingeschränkter Verwendung artikellos bleiben, stehen mit dem Artikel, sobald sie näher bestimmt werden.

IV. Gattungsnamen im Plural (wie im Deutschen):

Horses are useful animals	Pferde sind nützliche Tiere
Sheep feed in flocks	Schafe weiden in Herden

Bemerkung: Wie im Deutschen können Gattungsnamen im Singular auch in allgemeiner Bedeutung mit dem bestimmten oder unbestimmten Artikel gebraucht werden, z. B.:

The (or: A) horse is a useful animal
Das (Ein) Pferd ist ein nützliches Tier

Die Umgangssprache zieht hier den artikellosen Plural vor.

V. als Gattungsnamen im Singular nur man und woman:

As a rule, woman is physically weaker than man
Die Frau ist gewöhnlich körperlich schwächer als der Mann

VI. Auch Substantive, die verschiedene Wissenschaften bezeichnen, sind artikellos, sobald sie nicht näher bestimmt werden, z. B.:

Physics deals with matter and energy
Die Physik befasst sich mit der Masse und Energie

Linguistics studies languages
Die Sprachwissenschaft befasst sich mit Sprachen

EXERCISES

1. Insert "some" or "any": Today, we can travel to .... country in the world in a very short time. Is there .... thing that can exist without space, time or matter? Are there .... further questions? Infinity is greater than .... number you can think of. These natural phenomena can be still seen in .... regions.

I have met this problem .... where before. We obtained .... original answers to our questions. He wants to know .... thing more about it. We need .... one to help us in the archives. You must speak with .... body from your department. Time is .... thing that cannot be defined, but there is not .... thing that can exist without it. There are .... problems that are very difficult. She will be able to provide .... thing that you may need. They have .... knowledge of English.

2. Give the German Definitions for:

Chemistry	is the science of the composition of substances.
Mathematics	is the science which studies quantity. Arithmetic is the science of numbers. Geometry is the science of properties and relations of magnitude in space.
Biology	is the science of living organisms.
Botany	deals with the study of plants.
History	is the record and the explanation of events in the life of a nation or a state.
Medicine	is the science which deals with the human body and its diseases.
Philology	and linguistics study languages.
Physics	deals with matter and energy and their relationship; it is the study of light, electricity, heat, and so on.
Political economy	studies the laws which govern the relations of people in production.
Bio-engineering	is a new medical discipline. It is an organized collaboration between graduate engineers and medical scientists.

3. Insert articles where necessary:

Our definition furnishes only ... basic characteristics of ... units ... investigator must deal with. ... scientists endeavour to attain conception of ... reality with ... analytic method and ... exhaustive examination of ... material open to them for ... observation. ... steady increase in ... wages is ... factor to be reckoned with. ... vast amount of ... work still remains to be done in this field. Some additional materials necessary to complete ... study were gathered during ... spring of 1972. This book is ... most valuable contribution to ... study of ... obscure region of ... history of ... science. This excludes all ... possibility of ... doubt. After this has been done, ... radio receiver must separate ... desired signal from other signals. We do not aim at ... exhaustive treatment of ... subject. It turns out that ... problem can be reduced to ... problem in ... motion of one molecule relative to ... other, ... motion of their common centre of mass being treated separately.

4. Translate into English:

1. Zu den Werkstoffen der Elektrotechnik gehört Stahl, Stahlguss, Grauguss, Temperguss, Kupfer, Messing, Bronze, Aluminium, Blei, Zink, Zinn, Lagermetalle usw. 2. Die wichtigsten Leiterwerkstoffe sind Kupfer und Aluminium. 3. Als Austauschwerkstoff für diese beiden käme das Zink in Frage. 4. Kupfer ist wetter- und feuerbeständig. 5. Kleine Mengen an Phosphor, Mangan, Nickel und Eisen härten das Kupfer, dagegen machen es Schwefel, Blei, Wismut und Antimon brüchig. 6. Verunreinigungen, zum Teil schon in äusserst geringen Mengen, beeinflussen die Leitfähigkeit stets nachteilig und setzen sie recht erheblich ab bzw. erhöhen den elektrischen Widerstand. 7. Zink ist weich, bildsam, gut zu bearbeiten und leicht schmelzbar.

MECHANICS

This subject is concerned with the motions of bodies and the special circumstances that arise with a body at rest. Traditionally, by "mechanics" is meant NEWTONIAN mechanics, a science based on certain postulates whose nature and use will be discussed in this article.

The word "mechanics" implies a connection with machinery and the subject is of fundamental importance in engineering science. It is usual to refer to its practical applications as falling within the scope of "applied mechanics" and this title is frequently used to cover such subdivisions of mechanics as strength of materials, and elasticity, ballistics, fluid mechanics, etc.

The foundation of all these subjects is analytical mechanics and it can be divided into two related parts, namely dynamics and statics. Dynamics is concerned with the motion of bodies and is, itself, commonly subdivided into two branches: the first, called kinematics, deals with the geometrical aspects of dynamics - that is, with the motions of bodies without reference to what causes them; the second, called kinetics, is concerned with the effects of forces as they condition these motions. Statics, on the other hand, deals with bodies which are at rest.

Some of the various subjects of applied mechanics are concerned with the different types of body to which theoretical mechanics refers. The subjects of elasticity, plasticity and strength of materials, for instance, refer to particular types of deformable solids. The "bodies" may be fluid, however, giving rise to the subjects of fluid mechanics, namely, aerodynamics, lubrication, etc.

This lesson commences with a preliminary discussion of the nature of mechanics. It seems logical then to take up the simplest problems of kinematics, namely those concerning the motion of a point.

MOTION. - The commonest phenomena which we observe are those involving the movement of objects from one point to another. Walking, riding, flying, climbing, sailing, dancing, etc. are all familiar examples of motion.

Motion is the continuous change in position of an object or a particle. The line along which a moving particle travels is called the path of the particle or path of the motion. If the path is a straight line the motion is rectilinear; if it is a curved line the motion is curvilinear.

Plane motion is motion in which each point of the moving body remains at a constant distance from a fixed plane. Each point of the body moves in a plane, and that plane in which the center of gravity of the body moves is called the plane of the motion.

A rotation is such a motion of a rigid body that one line of the body or of an extension of the body remains fixed. The fixed line is the axis of rotation. The plane in which the center of gravity of the body moves is the plane of rotation, and the intersection of the axis of rotation and this plane is the center of rotation.

Position. Displacement. The position, at any instant, of a particle that has rectilinear motion is conveniently specified by its distance from a chosen fixed origin in the path. We call this distance the S-coordinate and customarily denote it by S. To indicate which side of the origin the moving particle is on, S is given a sign. Either direction along the path may be taken as positive and the other as negative. We assume for convenience that rectilinear motions are horizontal, and we take direction to the right as positive. The displacement of a particle for any given interval of time is Δs, the increment in its S-coordinate; it is equal to the distance between the initial and final positions of the particle, and is positive when the final position is to the right of the initial position.

If the direction of the motion does not change during a given interval of time, the displacement of the particle for that interval is equal to the distance it travels. But if the motion is reversed during the interval the distance travelled is greater than the displacement. If a particle moves so that it undergoes equal displacement in all equal intervals of time it has uniform motion; if it moves in any other way it has nonuniform motion.

Angular Displacement. - By angular displacement of a rotating body during any time interval is meant the angle described during that interval by any line parallel to the plane of rotation.

Forces and Motions. - The motions of bodies may be divided into three classes: 1) translation, 2) rotation, and 3) vibration or oscillation. A body is said to have a motion of translation when it moves on continuously in the same direction. An automobile running on a straight road are illustrations of motions of translation. If a body instead of travelling forward turns on a fixed axis, it has a motion of rotation. The drive wheels of a locomotive are moving forward and are at the same time rotating. Therefore they have two motions, one of rotation and the other of translation. Some bodies reverse their motions from time to time and return at regular intervals to their original positions. Such bodies are said to have a motion of vibration or oscillation.

Speed and Velocity. - The speed of a body is defined to be the rate at which the body is passing through space or the space passed over in unit time. It is determined by dividing the space over which a body has passed by the time required to pass over that space. It is a scalar quantity and has magnitude only.

$$\text{Speed} = \text{space per unit time} = \frac{\text{distance}}{\text{time}}$$

Velocity. - The velocity of a body has a directional quality in addition to its magnitude. Velocity is a vector quantity in contrast to speed, which is a scalar quantity. The magnitude of the velocity is the same as the numerical value of the speed. In giving the velocity of a body the direction of motion must also be specified. Directed speed, which is called velocity, is therefore a vector quantity.

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Addition of Velocities. - Suppose that a train is running at 10 mph and that a man walks forward on the train at the rate of 4 mph. The man has a forward velocity because of the motion of the train and also a forward motion because of his walking. His forward velocity with respect to the earth is the sum of these two velocities, or 14 mph. Now suppose that he walks backward on the train at the rate of 4 mph. Again he has two velocities, 10 mph forward, and 4 mph backward. His net velocity with respect to the earth is the difference between his forward and his backward velocity or 6 mph forward. In this case the two velocities lie along the same line and the resultant velocity is equal to the algebraic sum of the separate velocities. When the separate velocities lie along different lines, they must be added with proper regard for the directions of motion.

Resolution of Velocities.- As in the case of displacements, forces and other vector quantities, it is often convenient to replace a velocity by its components at right angles to each other. This process is called the resolution of velocities.

Acceleration. - We know the velocity of a particle to be continuously changing if this particle has non-uniform motion; in each successive time interval the particle acquires or takes on some increment of velocity. The time rate at which the velocity changes is the acceleration of the particle. This rate has magnitude, according to how much velocity is being taken on per unit of time, and direction, according to the direction of the velocity that is being taken on. The magnitude of acceleration is expressed in units of velocity per unit of time, as miles per hour per minute or feet per second per second (ft/sec/sec or ft/sec^2). The direction of the acceleration is conveniently indicated by sign, plus when to the right, minus when to the left.

Angular Acceleration. - The rate at which the angular velocity changes is called the angular acceleration. It is the increase or decrease in angular velocity per unit of time. It is related to the angular velocity in the same way in which the linear acceleration is related to linear velocity. In an angular acceleration as in linear acceleration it is necessary to specify two units of time. One of these units gives the unit of time in which the angular velocity is measured, and the other gives the unit of time used to measure the change in the angular velocity. Ordinarily, the same unit of time is used in both cases.

Harmonic Motion is a periodic motion, or vibration, along a straight line in which the restoring force is proportional to the displacement. It may be simple with only one frequency and amplitude, or it may have two or more simple components.

Any sort of motion which repeats itself in equal intervals of time is called *periodic*, and if the motion is back and forth over the same path it is also called *oscillatory*.

The Breakdown of Newtonian Mechanics .-

In spite of its immense success, classical - that is, Newtonian - mechanics breaks down, and it does so when it is applied to motions of the very large, of the very small and to motions of very high speed. These failures of the theory have given rise to *relativity theory* and to *quantum mechanics*. Both of these new theories arose mainly out of conflicts between the predictions of classical mechanics and the observed behaviour of electromagnetic waves and, in particular, of light.

RELATIVITY THEORY

In early electromagnetic theory, it was postulated that some transmitting medium was necessary for the transmission of light. This transmission was supposed to be in the form of light waves which were undulations in an all-pervading medium called the ether. By supposing this medium to have certain mechanical properties, and in particular that of elasticity, certain properties of these waves were deduced on the basis of classical mechanics. It was supposed that the velocity of light relative to the medium was the same in all directions. If this velocity is denoted by c, then, according to elementary kinematics, an observer moving relative to the ether along the track of a light wave with velocity v should observe that the light has a velocity $c - v$ along his direction of motion because he is tending to overtake the wave. In the opposite direction it should be $c + v$, and at right angles the unchanged velocity c.

Modern physical theory no longer requires the existence of an ether for the transmission of light so that classical mechanics is not now used to explain the passage of light waves in terms of the wave motions of an elastic medium. But, in disposing of the need for using the NEWTONIAN THEORY, Einstein introduced results which do not conform with classical mechanics. Einstein also extended his theory to the so-called GENERAL THEORY of RELATIVITY. This is essentially a theory of gravitation. Some of the motions of the planets, especially of Mercury, cannot be completely explained by Newton's laws.

It was suggested by J. Leverrier that the anomalous motion of Mercury could be explained by the influence of a small planet nearer the sun. However, that planet has never been seen and it was thought in the late 1950s that it is more likely that the explanation lies in the breakdown of Newton's law of gravitation. Although far from certain, Einstein's General Theory of Relativity appears to give the most probable explanation at the present time.

QUANTUM MECHANICS

The breakdown of Newtonian mechanics when it is applied to very small bodies was discovered by Lord Rayleigh and Sir James Jeans, again on the basis of calculations relating to the ether. Their calculations referred, in fact, to the energy of electromagnetic waves when they are propagated through the ether. They found the energy to be infinite. As this infinite energy was associated with the very short wave (i.e. ultraviolet) region of the spectrum, the result was picturesquely termed the "ultraviolet catastrophe".

The explanation of this anomaly was given by M. Planck and it is concerned with the so-called "quantization of energy". Although it is in contradiction with certain of the concepts of Newtonian mechanics, Planck's theory has been found to be in accord with experimental observations made on very small systems such as electrons or atoms. Its usefulness has not been impaired by the fact that the notion of an ether has now been generally discarded.

Later physical researches have led to the conclusion that Planck's theory, which has given rise to the study of quantum mechanics, is a refinement of the Newtonian scheme and that the latter can be regarded as a sort of "average" theory, valid for all bodies except those which are very small and those whose behaviour requires use of relativity theory.

QUESTIONS

1) Are Newton's laws likely to be used for ever ?
2) What does the word "mechanics" imply ?
3) When is the title "applied mechanics" frequently used ?
4) In what three states does matter exist ?
5) What is the difference between "elasticity" and "plasticity" ?
6) What is the difference between "motion" and "movement" ?
7) What do we call the moment of two parallel equal and opposite forces ?
8) What force acts on a rotating particle ?
9) Is the radius of gyration the same as the radius of rotation ?
10) What is damped harmonic motion ?
11) What forces act on a ship ?

IMPORTANT TERMS

acceleration	-	Beschleunigung f
addition (theorem) of velocities	-	Additionstheorem n der Geschwindigkeiten
angular acceleration	-	Winkelbeschleunigung f, Radialbeschleunigung f
angular displacement	-	Winkelverschiebung f, Phasenverschiebung f
applied mechanics	-	angewandte Mechanik
composition of velocities	-	Zusammensetzung f von Geschwindigkeiten
condition, to	-	bedingen; klimatisieren; konditionieren
curvilinear motion (movement)	-	krummlinige Bewegung
deformable	-	verformbar
displacement	-	Verschiebung f ; Wasserverdrängung f

driving wheel	Triebrad n
ether (ˈiːθə)	Aether m
gyration	Kreisbewegung f, kreisförmige Taumelbewegung
imply, to	einbeziehen, in sich schliessen
increment of velocity (speed)	Geschwindigkeitszunahme f
non-uniform movement	ungleichförmige Bewegung
path	Bahn f; Weg m; Verlauf m; Strecke f; Pfad m
path acceleration	Bahnbeschleunigung f
postulate, to	eine Forderung stellen, voraussetzen
preliminary	vorbereitend, einleitend; Vor -
rectilinear	geradlinig, zeilenförmig
resolution of velocities	Zerlegung f von Geschwindigkeiten
track	Bahn f; Spur f; Route f; Gleis n
yield stress	Fliesspannung f

GRAMMAR and NOTES

1. Either direction along the path may be taken as positive and the other as negative.

   Either wird in den Bedeutungen "jeder (von beiden)" und "der eine oder der andere" attributiv und substantivisch verwendet.

2. If the direction of the motion does not change during a given interval of time, the displacement of the particle for that interval is equal to the distance it travels.

   Anknüpfung ohne Relativpronomen: "Kontaktkonstruktion" (Contact Clause). Charakteristisch für das Englisch ist eine Konstruktion, bei welcher der bestimmende Relativsatz ohne Pronomen unmittelbar an sein Beziehungswort angeschlossen wird. Diese "Kontaktkonstruktion" ist immer möglich, wenn das gleichfalls verwendbare Relativpronomen (meist that) Objekt wäre:

   Are these the books ___ you bought yesterday?
   Sind dies die Bücher, die Sie gestern gekauft haben ?

   They hold debates on anything ___ they like.
   Sie veranstalten Diskussionen über alles, was sie nur wollen.

Die Kontaktkonstruktion findet sich auch dort, wo *that* *prädikativ* verwendet werden könnte.

He is not the man_he was before he came here.

Er ist nicht mehr der Mann, *der* er war, bevor er hierher kam.

Das gleiche gilt für Fälle, wo *that* als Subjekt vor *there is* zu stehen käme:

This copy is the only one_*there was* in the shop.

Dieses Exemplar ist das einzige, *das* sie im Laden hatten.

Auch diejenigen Fälle, in denen *that* wie ein *Adverb* verwendet werden kann, erscheinen als Kontaktkonstruktionen:

He did it in the way_I would have done it myself.

Er machte es ebenso, *wie* ich es selbst gemacht hätte.

By the time_we have finished, it will be too late.

Bis *dass* wir fertig sind, wird es zu spät sein.

3. *Word Study*

plastic = permanently deformable by stress

elastic = temporarily deformable by stress

plasticity is that property of a body by virtue of which it tends to retain its deformation after reduction of the deforming stress to its yield stress.

elasticity is the ability of a material to deform under stress and to return to its original shape upon removal of the stress.

All bodies are strained by stress: if the strain disappears after the stress is removed, the body is elastic; if the strain remains after the stress is removed, the body is plastic.

velocity = lineare Geschwindigkeit, Geschwindigkeitsvektor m (velocity vector)

speed = (Umlaufs- bzw. Dreh-)Geschwindigkeit (a scalar quantity expressed in units of length divided by time)

rotate or revolve = turn about an axis

The Earth rotates about its axis once a day.

The planets revolve in elliptical orbits about the sun, with the sun as a focus.

to rotate, rotatable (drehbar), rotary movement [motion] (Drehbewegung f), rotating (Drehen n), rotating field (Drehfeld n), rotation (Rotation f, Drehung f), rotation axis (Drehachse f), rotational speed (Umlaufgeschwindigkeit f, Drehzahl f), rotative (umlaufend, drehend; Dreh -), rotator, rotatory (rotierend, drehbar), rotatory motion (Rotationsbewegung f), rotor (Rotor m, Läufer m, Laufrad n, Schaufelrad)

to revolve, revolution, revolvable (drehbar), revolver, revolving (drehbar, kreisend; Dreh-)

to gyrate = kreiseln; taumeln

gyrating mass (Schwungmasse f)
gyration (Kreisbewegung f, kreisförmige Taumelbewegung)
gyratory (Kreiselbrecher m; sich drehend)
gyratory traffic (Kreisverkehr m)
gyro (Kreisel m, Kreisel -)
gyro system (Kreiselverfahren n [radar])
gyrobus (an electrical autobus)
gyrocar (Einschienenwagen m)
gyrodine (Flugschrauber m)
gyrograph (Umdrehungszähler m, Tourenzähler m)
gyrometer (Gyrometer m)
gyropilot (Selbststeuergerät n)
gyroplane (Tragschrauber m)
gyroscope (Kreisel m, Gyroskop n)
gyrostat (gekapselter Kreisel)
gyrostatics (Gyrostatik f, Kreisellehre f)
gyrosyne compass (Erdinduktionskompass m)

motion = usually something regular, e.g. motion (revolution) of the earth round the sun, or simple harmonic motion.

movement = something irregular and not continuous, e.g.

every movement of his arm caused him pain (jede Bewegung des Armes tat ihm weh); another meaning:

Labour Movement (Arbeiterbewegung f),
upward movement (Steigen n, Aufwärtsbewegung f, [der Preise]),
passive movement (passive Bewegung [Med.]),
to study s.o.'s movements (j-s Bewegungen beobachten),
social, religious, political movement (soziale, religiöse, politische Bewegung) etc.,

but also : movement of earth, moon, etc.

4. Some Symbols for

a) Kinematics

time	t
period (time of one cycle)	T
time constant (of an exponentially varying quantity)	τ
frequency	f, ν
rotational frequency (number of rotations in unit time)	n
angular frequency	ω
wavelength	λ
wavenumber	$\tilde{\nu}, \sigma$
circular wavenumber ($2\pi\sigma$)	k
velocity	u, v
angular velocity	a...f
angular acceleration	α
local gravitational acceleration (initial acceleration in free fall)	g
standard acceleration (9·806 65 m/s^2)	g_n
damping coefficient	δ
logarithmic decrement	Λ
attenuation coefficient	α
phase coefficient	β
propagation coefficient ($\alpha + j\beta$)	γ

b) Mechanics

mass	m
density	ρ
density, relative	d
momentum	p
force	F
weight	W
moment	M
pressure	p
work	W, w
energy	E
energy, kinetic	T
energy, potential	V
Lagrangian function	L
Hamiltonian function	H
power	P
efficiency	η
moment of inertia (second moment of mass)	I, J
radius of gyration	k
stress, normal	$\sigma \ldots f$
stress, shear	$\tau \ldots q$
strain, direct	$\epsilon \ldots e$
strain, shear	γ, ϕ
Young's modulus	E
shear modulus; rigidity	G
bulk modulus	K
compressibility	k
Poisson ratio	$\nu \ldots \sigma$
bending moment	M
torque	N, T
coefficient of friction	μ
viscosity (dynamic viscosity)	η, μ

kinematic viscosity	γ
surface tension	γ, σ
Mach number	(Ma) ... M, M_n
Reynolds number	(Re) ... R, R_n

EXERCISES

1. Define in English and form sentences with the following words:
   acceleration, velocity, energy, force, work, power, efficiency, radius of gyration, moment of inertia, static moment, centrifugal force, angular velocity, center of gravity.

2. Form adverbs from the following adjectives:
   possible, full, extreme, quick, good, fast, happy, dynamic, little, mechanic, static, magnetic, long, short, true, low, independent, arithmetical.

3. Form Contact Clauses from the following sentences:

   The material will be supplied regularly; further research depends upon it. Evidently the method could be of great value; the author has outlined it. There is one point; we have not dealt with it so far. The four steps are continually repeated; the procedure consists of them. The solution seems satisfactory; the author proposes it. The conclusions must be verified; we have arrived at them. The device seems very effective; you have mentioned it. The papers are available in our library; the author refers to them.

4. Translate into English:

   1) Anfang oder Ende kann im Unendlichen liegen. 2) Je länger der Weg des Stromes ist, um so grösser ist der Widerstand. 3) Der Transformator muss stets vollständig mit Oel gefüllt sein, damit jede Bildung von Kondenswasser vermieden wird. 4) Die Berichte haben gezeigt, dass eine ganze Reihe von Einzelmassnahmen möglich ist, um das Abwasser der Energiewirtschaft rein zu halten. 5) Hochspannungsanlagen sind Anlagen, deren Spannung gegen Erde mehr als 250 V beträgt. 6) Wir werden nicht alles kaufen können, was wir möchten. 7) Die Zahl der Studenten, die sich in dieser Klasse befinden, ist ziemlich klein.

LESSON SEVEN

DYNAMICS

Laws of Motion

Thus far we have studied the laws of motion, without asking, "What is it that causes a body to move ?". We know that a force is needed in order to change the motion of a body, that is, in order to accelerate it or decelerate it, or to change its direction. In the absence of a force, a body will either remain at rest, or continue to move with constant speed in a straight line. These conclusions are summed up in three statements known as laws of motion.

The first law:

A body at rest remains at rest and a body in motion remains in motion at a constant speed in a straight line, unless acted upon by an external force.

Thus the first law involves the idea of motion and the idea of force. It explains what is to be understood by force: it is that which tends to change the state of rest of a body, or of uniform motion in a straight line. The first law, however, tells us more than this. It tells us that if a body is kept free from the action of forces, it will remain in its state of rest or of uniform motion in a straight line. Thus the normal state for a body to be in is one of rest or of uniform motion in a straight line, i.e. motion with uniform velocity; it is only the presence of force which can alter this normal state.
The property by virtue of which a body tends to remain in either

of the natural states, and to resist being accelerated, is called inertia. In this sense, inertia is an absolute quality possessed in equal degree by all bodies, because all bodies are completely inert.

The second law:

Rate of change of motion of a body is proportional to the applied force and is in the direction in which the force acts.

By motion is here meant quantity of motion or momentum. It is defined as the product of the velocity and a quantity called the mass of the body. Using the word momentum, the second law may also be stated as follows:
Rate of change in momentum of a body is proportional to the applied force and is in the direction in which the force acts.

The third law:

To every action there is always an equal and opposite reaction.

It is a matter of common observation that a body A cannot exert force on a second body B without B at the same time exerting force on A. Thus all forces occur in pairs, which may conveniently be spoken of as action and reaction. The third law of motion tells us that the two forces which constitute such a pair are equal in magnitude and opposite in direction.

WORK, POWER, ENERGY

WORK

Work is done by a force when the point of application of the force moves so that the force has a component along the path of the point of application. If the working component is constant, the amount of work done is equal to the product of the magnitude of the working component and the distance through which the force acts. When the working component acts in the direction of the motion, the work of the force is positive; when the working component acts oppositely to the direction of motion, the work of the force is negative. Forces which do positive work are sometimes called *efforts*; those which do negative work, *resistances.*

We denote work by W.

Since it is the product of two scalar quantities, work is a scalar quantity. It can be expressed in any units of force and distance.

Gravitational Units of Work.— Since work is measured by the product of the force times the distance through which it acts, it is necessary to measure two quantities - force and distance.

In the metric system the unit of work may be chosen as the *gram-centimeter* or the *kilogram-meter.*

The gram-centimeter is the amount of work done when a mass of 1 g is lifted a vertical distance of 1 cm at constant speed against the action of gravity.

The Erg. - The gravitational units of work, like the gravitational units of force which enter into them, depend on the place on the surface of the earth at which they are used. For this reason an absolute unit of work, *the erg*, is frequently used. An erg of work is the work done when a force of 1 dyne acts through a distance of 1 cm. Since the weight of 1 g is equivalent to 980 dynes, a gram-centimeter of work is equivalent to 980 ergs. When a mass of 1 g is lifted a distance of 1 cm against the force of gravity, 980 ergs of work are done.

POWER

In defining work as the force multiplied by the distance through which it acts, it is to be observed that the element of time does not enter. The amount of work done is measured by the end result, and it does not in any way depend upon the time to do the work. In the consideration of a machine it is necessary to know more than the total amount of work that the machine can do. It is desirable to know the rate at which the machine works. The time rate of doing work is called *power*.

Hence

$$\text{Power} = \frac{\text{work}}{\text{time}} = \frac{\text{force} \times \text{distance}}{\text{time}} = \frac{F \times s}{t} = \text{work, per unit of time}$$

$$\text{Since } \frac{s}{t} = v$$

$$\text{Power} = \text{force} \times \text{velocity} = Fv$$

The English unit of power is called the *horsepower* (hp).

ENERGY

When the state or condition of a body is such that it can do work, the body is said to possess energy. It is customary to distinguish several kinds of energy. Thus a body may have *kinetic energy* by virtue of its motion, *potential energy* by virtue of its position in a field of force or by virtue of its state of internal stress, *thermal energy* by virtue of its temperature, *chemical energy* by virtue of its chemical composition. The amount of energy, of any given kind, that a body possesses at a given instant is the amount of positive work the body can do in changing from the condition it is in at that instant to some other condition taken as standard.

Energy is measured in the same units as work and, like work, is a scalar quantity.

Potential energy is the energy a body possesses by virtue of its position or configuration relative to some standard position, or configuration, and is measured by the amount of work required to get it into its position, or configuration, or by the amount of work it can perform in returning to its original position, or configuration, with neglect or omission of any dissipated work.

Kinetic energy is the energy a body possesses by virtue of its velocity relative to a reference frame and is measured by the work done upon it to get it into its present motion, or numerically by the work that must be performed upon it to bring it to rest, or, finally, by the work it can do in being brought to rest, with neglect or omission of dissipated work.

QUESTIONS

1) What is it that causes a body to move ?
2) What is needed in order to change the motion of a body ?
3) When will a body remain at rest ?
4) When will a body continue to move with constant speed in a straight line ?
5) What idea does the first law of motion involve ?
6) What does the second law of motion explain ?
7) What is to be understood by force ?
8) Why does the expression "change of motion" require explanation ?
9) How may be stated the third law of motion ?
10) What is to be understood by action and reaction ?
11) What do we call the working component of the force ?
12) When is the work of the force positive ? negative ?
13) By what is work measured ?
14) What is an erg of work ?
15) What do we call the horsepower ?
16) How many kinds of energy do we distinguish ?
17) In what units is energy measured ?

IMPORTANT TERMS

decelerate, to	verlangsamen, verzögern; Geschwindigkeit herabsetzen
dissipate, to	vergeuden, verschwenden, zerstreuen, verschwinden
dissipation of energy	Energieverlust m
dissipation of heat	Wärmeableitung f, Wärmeabstrahlung f
dissipative force	dissipative Kraft
dissipative system	Abstrahlvorrichtung f, Verteilungssystem n
inert	inert; träge, passiv; indifferent
inert mass	träge Masse
inert speed	Beharrungsgeschwindigkeit f
inertia	Trägheit (skraft) f, Beharrungskraft f, Beharrungsvermögen n
inertia effect	Beharrungswirkung f, Beharrungsmoment n, Trägheitsmoment n
inertia force	Trägheitskraft f, Massenkraft f
inertia mass	Beharrungsmasse f (Regler), Schwungmasse f
inertia moment	Trägheitsmoment n
inertial flight	Trägheitsflug m
inertial force	Trägheitskraft f
inertial motion	Trägheitsbewegung f
inertness	Massenwiderstand m; Trägheit f
momentum	Bewegungsgrösse f, Impuls m, bewegende Kraft , Stosskraft f
reference frame	Messrahmen m

GRAMMAR and NOTES

1. The property by virtue of which a body tends to remain in either of the natural states, and to resist being accelerated, is called inertia.

Mit dem Partizip hat das Gerundium an verbalen Eigenschaften gemeinsam,

a) dass es durch die gleichen vier Formen sowohl Aktiv und Passiv wie auch das Zeitverhältnis zum Hauptsatz zum Ausdruck bringen kann:

Aktiv	Passiv
asking	being asked
having asked	having been asked

Die einfachen und die Perfekt-Formen stehen dabei gewöhnlich in demselben Verhältnis (der Gleichzeitigkeit oder des Vorhergehens) zum Tempus des Hauptsatzes wie die entsprechenden Formen des Partizips.

b) dass es ein direktes Objekt anschliessen kann:

He hates smoking cigarettes. Er mag das Zigarettenrauchen nicht.

c) dass es durch Adverbien näher bestimmt werden kann:

What really matters in language-learning is listening actively.

Worauf es beim Sprachenlernen wirklich ankommt, ist, dass man aktiv zuhört.

Für die Satzanalyse ist zu beachten, dass die - ing-Form als Verbalsubstantiv anzusehen ist, sobald ihre Konstruktion kein verbales Merkmal aufweist. Es ist hierbei also zu unterscheiden zwischen Konstruktionen wie

a)	He hates smoking: Die-ing-Form ist wie ein substantivisches Objekt verwendet und hat kein verbales Merkmal: Verbalsubstantiv	He hates smoking cigarettes: Wie bei einem Verb ist ein direkte Objekt an die-ing-Form angeschlossen. Dabei ist smoking cigarettes (wie ein Substantiv) als einheitliches komplexes Objekt aufzufassen: Gerundium
b)	Careful listening is important: Die-ing-Form als Subjekt wird (ebenfalls wie ein Substantiv) durch ein Adjektiv ergänzt; kein verbales Merkmal: Verbalsubstantiv	What really matters ... is listening actively: Die-ing-Form ist hier (wie ein Substantiv) Prädikatsnomen, wird aber zugleich wie ein Verb durch ein Adverb ergänzt: Gerundium

Wie die Beispiele zeigen, sind die Uebergänge zwischen Verbalsubstantiv und Gerundium fliessend. Das Vorhandensein oder Fehlen einer Ergänzung (direktes Objekt !) oder aber die Art der hinzutretenden Ergänzung (z.B. :Adjektiv oder Adverb) entscheidet über die jeweilige grammatische Funktion der-ing-Form. Dies erklärt, dass nach allen Präpositionen und allen Verben, die das Gerundium verlangen oder zulassen, im allgemeinen auch das Verbalsubstantiv stehen kann.

2. By motion is here meant quantity of motion or momentum. To this class of substance belong mica, porcelain, quartz, glass, wood, ebonite, etc.

Inversion des Objekts. Hervorhebende Voranstellung des Objekts vor das meist pronominale Subjekt findet sich gelegentlich wie im Deutschen

a) um einen besonders engen Zusammenhang mit dem Vorangegangenen herzustellen, wie z.B. in

The news of it I shall always remember.	An die Nachricht (davon) werde ich mich stets erinnern.

b) um einen Gegensatz zum Vorangegangenen auszudrücken.-

3. The first law explains what is to be understood by "force". Now we are to study the motion of a body ...

Die Verbindung to be to + Infinitiv wird im Präsenz und Präteritum als modales Hilfsverb in der Bedeutung "sollen" verwendet. Durch to be to wird entweder eine Anordnung (meist eines Dritten) übermittelt oder aber ein künftiges Geschehen als vereinbart oder geplant gekennzeichnet. Im letzteren Fall kann to be to auch als Futurumschreibung angesehen werden.

He is to arrive tomorrow. Er soll (oder: wird) morgen ankommen.

Im Präteritum ist was/were to die normale Entsprechung des deutschen Indikatives "sollte" :

What was I to do ?	Was sollte ich tun ?

Die verneinten Formen von to be to bringen sinngemäss ein Verbot zum Ausdruck:

He says I am not to do it again.	Er sagt, ich soll(e) es nicht wieder tun.

Um auszudrücken, dass eine geplante Handlung unterblieben ist, wird hier der Infinitiv des Perfekts verwendet :

He was to have arrived the next morning. (But he did not arrive).	Er hätte am nächsten Morgen ankommen sollen. (Er kam aber nicht).

4. In defining work as the force multiplied by the distance through which it acts, it is to be observed that the element of time does not enter.

Infinitive im Prädikat stehen ebenfalls im Passiv ; dabei kann auch ein Adverb vorangehen:

it is clearly to be understood.

Adjektivisch gebrauchte Infinitive stehen im Englischen im Passiv:

the work to be done - die zu verrichtende Arbeit
the atomic power station to be constructed - das zu erbauende Atomkraftwerk

5. Force - power - strength

force = 1) Kraft f (in dynamics and statics)
2) Kraft f, Macht f (any operating agency)
3) Gewalt f, Stärke f (in figurative meaning)
4) Kriegsmacht f (often in pl.: forces) "Streitkräfte"f (pl)
5) Formteil n (in plastics industry)

power = 1) Kraft f, Stärke f (in general)
2) Energie f, Kraft f, Leistung f, Leistungsvermögen n (in physics - any form of energy)
3) mechanische Energie (in mechanics - the rate of doing work)
4) Leistung f (of an electrical motor or machine)
5) Potenz f (in mathematics)
6) Sendestärke f (in radio engineering)
7) Stärke f, Vergrösserungskraft f (in optics)
8) Befugnis f, Vollmacht f (in legislature)
9) meist pl.: Macht f, Regierung f, Staat m (the great powers - die Gross - mächte)

strength = 1) Kraft f,Stärke f (in general)
2) Festigkeit f, Widerstandsfähigkeit f, Bruchgrenze f (in mechanics)
3) Stärke f, Intensität f,(in physics - of light, sounds, etc.)
4) Gehalt m, Stärke f (in chemistry - of a solution)

5) **Festigkeit f (in financial matters)**
6) **Dicke f (glass manufactures)**
7) **Truppenstärke f (military)**
8) **Stärke f, Wirkungskraft f, Wirkungsgrad m (electr.,chem., phys.)**

EXERCISES

1. Insert "force", "power" or "strength" as required by the meaning of the sentence:

Squaring means raising to the second .... The Royal Air Force is a branch of His (Hers) Majesty's .... is always a vector, ... is a scalar, ... usually is, but need not be a vector. The ...... of an electric current is measured in amperes. Electric field .... is measured in volts/cm. Pressure is the ratio of .... to area. The robber took the money by ....

2. Translate into German:

Laws of Friction. The laws which determine the amount of friction between the dry surfaces of solids are as follows:

a) The friction between two sliding surfaces is nearly independent of the velocity.

b) If the force perpendicular to the surface remains the same, the friction does not depend on the area of the rubbing surfaces. This statement is only approximately true.

c) The force of friction is proportional to the total force pressing one surface against another.

d) The force of friction is greater at the start than after motion has begun.

3. Translate into English:

1) Auch die mit Strom zu versorgenden grossen Pumpenanlagen für Bewässerungszwecke können mühelos an die Leitungen angeschlossen werden.
2) Die bei Transformatoren anzuwendende Schaltung richtet sich nach dem Verwendungszweck.
3) Mit zunehmendem Phasenwinkel verringert sich die zu erzielende Leistung, die Maschinen und Geräte werden nicht voll ausgenutzt.

CONSERVATION OF ENERGY

LOSSES. In physics, the study of the various forms in which energy may occur and the transformation of one kind of energy into another has led to the important principle known as the principle of the conservation of energy. Briefly, this states that energy can never be created or destroyed. It can be transformed from one form to another, but the total amount remains unchanged. Thus, an electric motor converts electrical energy into mechanical energy, the incandescent lamp changes electrical energy into heat energy, the loud-speaker converts electrical energy into sound energy, the generator converts mechanical energy into electrical energy, etc. In each instance, the transformation from one type of energy to another is not accomplished with 100 percent efficiency because some energy is converted into heat and does no useful work as far as that particular conversion is concerned.

Resistance in a circuit may serve a number of useful purposes; but unless it has been specifically designed for heating or dissipation purposes, the energy transformed in the resistance generally serves no useful purpose.

EFFICIENCY. Because every electrical apparatus contains resistance, there must always be some heat developed when current flows. Unless the apparatus is to be used for producing heat, the heat due to the resistance of the apparatus represents wasted energy. No electrical apparatus or other machine is capable of converting energy received into useful work without some loss.

The power that is furnished a machine is called its input, and the power received from a machine is called its output. The efficiency of a machine is equal to the ratio of the output to the input.

That is,

$$\text{Efficiency} = \frac{\text{output}}{\text{input}} \qquad /7/$$

It is evident that the efficiency, as given in Eq. /7/, is always a decimal, that is, a number less than 1. Naturally, in Eq. /7/, the output and input must be expressed in the same units. Hence, if the output is expressed in kilowatts, then the input must be expressed in kilowatts; if the output is expressed in horsepower, then the input must be expressed in horsepower, etc.

Problems

1. A certain radio receiver consumes 120 W. At 3.5 cents per kilowatt-hour, how long could this receiver be operated for $ 1.00?

2. An electric percolator that consumes 175 watts is used 45 min each day. At 4 cents per kilowatt-hour, how much will it cost to use the percolator for 30 days?

3. A motor takes the equivalent of 15 hp from a 220-V line. How much current does the motor take?

4. A voltage of 50 μV is applied across a 300-Ω resistor.
   a) How much power is expended in the resistor?
   b) How much current flows through the resistor?

5. A motor is delivering 10.5 hp. A kilowattmeter that measures the power taken by the motor reads 9.80 kW.
   a) What is the efficiency of the motor?
   b) At 2.7 cents per kilowatt-hour, how much would it cost to run this motor continuously for 1 week?

QUESTIONS

1) What do we call the principle of the conservation of energy? 2) Can energy be transformed from one form to another? 3) Does an electric motor convert electrical energy into mechanical energy? 4) Is the transformation from one type of energy to another accomplished with 100 per cent efficiency in each instance? 5) What does every electrical apparatus contain? 6) What does the heat due to the resistance of the apparatus represent? 7) Is any electrical apparatus or other machine capable of converting energy into useful work without some loss? 8) What do we call the power received from a machine? 9) What is input? 10) To what is the efficiency of a machine equal? 11) Is atomic energy likely to be used for industrial purposes?

IMPORTANT TERMS

accomplish, to (ə'kɔmpliʃ)	ausführen, zustande bringen
amount, to (ə'maunt)	steigen, sich belaufen (auf - to), betragen, ausmachen
amount	Betrag m, Summe f, Bestand m, Menge f
conservation of energy	Erhaltung f der Energie, Energieerhaltung f
convert, to (kən'vəːt)	umwandeln, verändern; umformen, umspannen
current ('kʌrənt)	1) Strom m, Fluss m ; 2) laufend, gültig, gegenwärtig
design, to (di'zain)	konstruieren; entwerfen; auslegen (Maschinen); bemessen, berechnen
design	Konstruktion f, Bauweise f, Form f; Entwurf m; Bemessung f, (Bauteile) Berechnung f, Muster n (auf Stoffen)
dissipation	Zerstreuung f; (el) Verlustleistung f
efficiency (i'fiʃənsi)	Nutzleistung f, Nutzeffekt m, Wirkungsgrad m; Leistungsfähigkeit f Ausbeute f (z. B. an Neutronen)

furnish, to ('fə:niʃ)	ausstatten, ausrüsten; liefern; möblieren
heat energy	Wärmeenergie f
incandescent lamp ('inkæn'desnt ...)	Glühlampe f
input	Eingangsleistung f, Leistungsaufnahme f; zugeführte Energie; Eingangswert m; Aufwand m; Eingangssignal n, Eingangsgrösse f, Eingangsinformation f; Eingabe f; Eingabevorrichtung f
loudspeaker	Lautsprecher m
output	Arbeitsleistung f, Leistung f, Produktion, Fertigungsmenge f; Leistungsfähigkeit f; Fördermenge f; Ausstoss m (Stahl); Abtrieb m (Getriebe); Ausgabe(Information) f, Ausgangsinformation f, Ausgangsgrösse f, Ausgangssignal n
resistance (rizistəns)	Widerstand m; Beständigkeit f Festigkeit f (Werkstoff)
sound	Schall m, Klang m, Ton m; Sonde f
waste, to (weist)	vergeuden, verschwenden; abnützen, abreiben

GRAMMAR AND NOTES

Unless the apparatus is to be used for producing heat, the heat due to the resistance of the apparatus represents wasted energy.

Konditionale Nebensätze können eingeleitet werden durch

unless (=if ... not)	wenn nicht; falls nicht
in case	falls; für den Fall, dass
on condition that	unter der Bedingung, dass
provided (that)	vorausgesetzt dass; unter der Voraussetzung, dass
if (only)	wenn (nur); falls
even if, even though	selbst wenn

Auch: suppose (that), supposing (that) = "angenommen (dass)" und so (or: as) long as = "vorausgesetzt (dass); wenn" leiten konditionale Nebensätze ein, die dann gewöhnlich vor dem Hauptsatz stehen.

Soll in Beziehung auf etwas Zukünftiges eine Bedingung als blosse Annahme oder Möglichkeit hingestellt werden, so wird im Nebensatz das Präteritum und im Hauptsatz der Konditional I (oder konditionales could, might, ought to, should) gesetzt, z. B.:

She wouldn't do it unless she had to.

Sie würde es nicht tun, wenn sie es nicht müsste.

Soll in Beziehung auf bereits Vergangenes eine Bedingung als irreal (als nicht erfüllt) gekennzeichnet werden, so wird im Nebensatz das Plusquamperfekt und im Hauptsatz der Konditional II gesetzt, z. B.:

He should have gone if this had not happened.

Er wäre gegangen, wenn dies nicht geschehen wäre.

Beachte für alle Bedingungssätze:

a) Im konditionalen Nebensatz darf weder Futur noch Konditional stehen.

b) Inhaltlich (bedeutungsmässig) ist der Hauptsatz (die Folgerung) abhängig vom Nebensatz (Bedingung).

Konstruktionsmässig ist der Nebensatz (wie im Deutschen) abhängig vom Hauptsatz.

EXERCISES

1. Complete the following If-Clauses:

If electricity (not to be) discovered, the telephone would not have been invented. Nobody knows if cold light (to be) discovered soon. If one side of a triangle (can) be greater than the sum of the other two sides, then the shortest distance between two points could not be a straight line. If two quantities (to be) equal to a third quantity, they are also equal to each other. If Newton (not to discover) the fundamental laws of mechanics, somebody else would probably have discovered them. If $\sqrt{2}$ (to be) a rational number, we could express it as a fraction of two integers. The law of the conservation of energy would be proved wrong if we (can) produce a perpetuum mobile (pə'petʃuum'məubilei oder auch: pəː'petjuum'məubili).

2. Omit "if" and use inversion (where possible):

If Pythagoras (pai'θægəræs) had known that it is impossible to square the circle, he would not have tried to do it.

If the power supply of that transmitter should fail, use the emergency supply. Faraday would not have become famous if he had not discovered electro-magnetic induction. If we could produce completely linear amplifiers, we should avoid harmonic distortion.

3. Translate into English:

   1. Der Name Physik stammt aus dem griechischen Altertum und bedeutet allgemein Naturforschung.

   2. Die Physik ist die Lehre von solchen Naturvorgängen, die der experimentellen Erforschung, der messenden Erfassung und mathematischen Darstellung zugänglich sind und allgemeingültigen Gesetzen unterliegen.

   3. Die Physik gliedert sich in eine Reihe von Disziplinen: Mechanik, Akustik, Wärmelehre, Optik, Magnetismus, Elektrizitätslehre.

   4. Auf allen diesen Gebieten gingen von jeher experimentelle Forschung (Experimentalphysik) und theoretische Ueberlegungen (theoretische Physik) Hand in Hand.

   5. Wesentlicher ist die moderne Unterscheidung von Makrophysik und Mikrophysik.

   6. Heute steht die Physik vor dem neuen Problem der Erforschung des Aufbaus der Atomkerne und Elementarteilchen.

   7. Die Steigerung der Produktion in der Industrie wäre ohne den elektrischen Strom nicht denkbar.

   8. Wenn man elektrische Energie allein aus Kohle erzeugen wollte, so würden die Vorräte bald aufgebraucht sein.

   9. Wenn du dich auf das Examen besser vorbereitet hättest, so würdest du es bestanden haben.

LESSON NINE

GASES and LIQUIDS

GASES

A gas is a very scattered assembly of molecules moving as fast as bullets but not getting very far before they collide with each other. Each molecule has a good big free space round it: in fact, a molecule of a gas has about a thousand times as much elbow-room as a molecule of a liquid or a solid.

The Ways of Storing Gases

On the industrial scale, there are three favourite ways of storing gases. First, they are stored in gasometers over water, or under a sliding piston or diaphragm.

Secondly, gases are stored in cylinders under high pressures.

Thirdly, some gases can be made into liquids by compressing them, and these are sold in strong glass syphons or iron cylinders.

Compressed and Liquefied Gases

Air and all other gases are very compressible and if the pressures are not too enormous they are all equally compressible. It may seem odd that gases as different as oxygen, hydrogen, chlorine, and steam are all equally compressible, but the reason is not difficult to understand. It follows first from the fact that all molecules have the same average energy at any given temperature; in other words, any molecule, at, say, 10° C, whether of oxygen or hydrogen or chlorine, on the average hits just as hard as any other.

The light swift molecules of hydrogen on an average hit just as hard as the slow heavy ones of chlorine. Secondly, it follows from the interesting fact that the same volume of any gas contains the same number of molecules.

Liquefaction of Gases

If pressure is put upon any gas the molecules are crowded by the pressure towards each other, and when they get very near to each other they get within the range of each other's attraction. If the gas is one like carbon dioxide or sulphur dioxide, the crowded molecules may pull on each other so strongly that they hang together and the gas becomes a liquid. It is thus possible to turn many gases into liquids simply by compressing them. Any gas in fact can be turned into a liquid by compressing it - as long as it is not too hot. The jostling of the molecules, which we call heat, prevents the molecules clinging together and making a liquid; the attraction of the molecules pulls them together and causes them to make a liquid. Gases like oxygen or hydrogen can only be liquefied by pressure if their molecules are calmed down by a great deal of cooling. The liquefying of gases is an important industry.

Expansion of Gases

Just as we can cool a gas by making it do work, so we can heat it by doing work upon it. The expansion of a compressed gas is used in driving steam engines, petrol engines, hot-air engines, etc. Gases expand very largely when they are heated. An interesting thing is that all gases expand to exactly the same extent when heated under the same conditions, which is by no means true for liquids or solids. When a liquid or solid is heated and expands there are two forces at work. The molecules are speeded up and so tend to swing in bigger orbits or to get further from each other. This effect is the same for all solids or liquids. But the attraction of the molecules opposes this effect; consequently substances whose molecules attract each other strongly will expand little and vice versa. But the molecules of gases are too far from each other to attract each other appreciably, so the effect of heating them is simply to increase the speed and energy of the molecules and make them bounce off each other harder and so fly farther apart. As the same rise of temperature means the same increase of energy, all gases expand equally.

Kinetic Theory of Gases

To explain the physical properties of gases, three basic assumptions are necessary:

1) The molecules of a gas are extremely small, perfectly elastic spheres. This assumption implies that when molecules of gas collide with other molecules or with the walls of the containing vessel, the total kinetic energy of the molecules is not diminished in any way.

2) The molecules move with changing velocities through the space occupied by the gas. Between collisions, their paths are straight lines. This assumption implies that the forces acting on the molecules are negligible except at collision.

3) The time occupied in a collision between two molecules or in a collision of a molecule with the wall is small compared with the time between collisions. This assumption implies that a collision is nearly instantaneous.

Specific Heats of Gases

The specific heat of a gas depends on whether the gas is heated at constant volume or at constant pressure. These two specific heats are known as specific heat at constant pressure and specific heat at constant volume.

Properties of Gases

Just as water is the most widely distributed and most important of liquids, so the air is the most important of gases. It consists for the most part of two elements that are mixed together but not chemically combined. These elements are oxygen and nitrogen. In spite of the fact that there is no chemical union between them, the composition of the air is extraordinarily constant. Besides oxygen and nitrogen, the air contains small parts of other gases, the most important of which are water vapour and carbon dioxide.

Boyle's Law. Relation between Pressure and Volume of a Gas.

The relation between the volume of any mass of gas and the pressure exerted by the gas upon the walls of the containing vessel was investigated by Robert Boyle and is known as Boyle's law. This law states that at constant temperature the volume of a given mass of gas is inversely proportional to the pressure to which it is subjected. For high pressures and low temperatures this law is only an approximation. Gases that can be liquefied by the application of pressure do not obey this law near the temperature and pressure at which they begin to liquefy.

LIQUIDS

Liquids at Rest. Characteristics of Liquids.

The molecules of a liquid at rest are displaced by the slightest force, and for this reason a liquid has no shape of its own but takes the shape of the containing vessel. Hence, liquids yield to a continued application of force that tends to deform them or to change their shape in any way. They, however, manifest wide differences in their readiness to yield to distorting forces. Water, alcohol and ether are very mobile liquids which yield readily to forces tending to change their shape. Glycerin is less mobile, and tar is still less so. There is no sharp line of separation between liquids and solids. All liquids offer large resistance to forces tending to change their volume.

Liquids in Communicating Vessels

It is a matter of common experience that liquids seek their own level in communicating vessels. If tubes of various sizes are connected, liquid poured into one of these tubes will come to the same level in all the tubes. This result is to be expected from the fact that the pressure in a liquid depends on the depth below the free surface. If points in the interior of the liquid are at the same level, the pressure at these points must be the same, or the liquid would flow from one point to the other until the pressure was equalized.

A Hydraulic Press produces large forces. Pressure is transmitted uniformly throughout the liquid. Hydraulic presses are used in baling paper, cotton, etc., in punching holes through steel plates, and extracting oil from seeds. By means of them, a small force operating through a large distance produces a large force operating through a small distance.

Archimedes' Principle, Buoyancy of Liquids

It is a matter of common experience that bodies are lighter in water than they are in air. When a diver lifts a stone under water and brings it to the surface, he finds that the stone is heavier above the surface. In the case of lighter bodies such as wood or cork, this lifting effect may be sufficient to keep parts of the body above water. This resultant upward pressure of a liquid on a wholly or partly immersed body is called buoyancy. It is vertical force which a fluid exerts on a body, wholly or partially submerged in it, when the overall specific gravity of the body is less than that of the fluid. That point through which the force of buoyancy acts is the centre of buoyancy. This point lies at the centre of gravity of the displaced liquid. The buoyant force of all the displaced liquid might be replaced by a single force acting through the centre of buoyancy without altering the behaviour of the body. This analysis makes it possible to formulate Archimedes' principle which states that the loss of weight of a body immersed in a fluid is equal to the weight of the displaced fluid, or a body immersed in a fluid is buoyed up by a force equal to the weight of the fluid displaced by it.

Density and Specific Gravity

In order to determine the density of a body, it is necessary to determine its mass and its volume. The density is then found by dividing the mass by the volume. The mass of the body is easily determined by weighing, but it is sometimes difficult to find the volume, especially when the body has an irregular shape. In such cases, the volume may be determined by an application of Archimedes' principle. Since the body displaces a volume of water equal to its own volume and since each cubic centimeter of water weights 1 g, the loss of weight in water is numerically equal to the volume of the immersed body. The numerical value of the density of a body depends on the units in which the mass and the volume are measured. In the C.G.S. system, the density is the number of grams per cubic centimeter.

The specific gravity of a body is the ratio of its density to the density of water at 4° C. Since in the C.G.S. system a gram is defined to be the weight of a cubic centimeter of water at 4°C, the numerical values of the density and the specific gravity in this system are the same.

Density of Solids Heavier than Water

When a body is heavier than an equal volume of water and is insoluble in water, its volume can be determined by finding its loss in weight when weighed in water. This loss of weight is equal to the weight of the water displaced, and if this loss of weight is expressed in grams, it is numerically equal to the volume of the body in cubic centimeters. By dividing the mass of the body by this volume, the density is obtained.

Density of Solids Lighter than Water

When a body is lighter than water but insoluble, its volume may still be determined by this method by fastening to the body a sinker large enough to force it below the surface of the water. In this case, the combined weight of the body and the sinker is first determined when the sinker is immersed in water and the body is above the surface of the water. The body is then also submerged and the combined weight redetermined. The change in weight is due to the buoyant force of the water on the body and equal to the weight of the water displaced by the body. It therefore gives the volume of the body in cubic centimeters. The density is then determined as in the preceding case.

QUESTIONS

1) What is a (perfect) gas ?
2) What happens to a gas when it is cooled ?
3) How many ways of storing gases are there ?
4) When does acetylene explode ?
5) What are compressed and liquefied gases used for ?
6) How is it possible to turn many gases into liquids ?
7) When is the expansion of a compressed gas used ?
8) What does the specific heat of a gas depend on ?
9) What is the specific heat at constant volume ? at constant pressure ?
10) What is the composition of the air ?
11) What does Boyle's law state ?
12) Why do all liquids offer large resistance to forces tending to change their volume ?
13) Why do liquids seek their own level in communicating vessels ?
14) Where are used hydraulic presses ?
15) What does Archimedes' principle state ?
16) What is called the centre of buoyancy ?
17) What is the specific gravity of a body ?
18) At what temperature is the density of water greatest ?
19) How do we determine densities of floating bodies ?
20) Was Archimedes likely to discover displacement and upthrust without taking a bath ?

IMPORTANT TERMS

bale, to	-	in Ballen verpacken, emballieren
baling press	-	Ballenpresse f, Packpresse f
buoyancy ('bɔiənsi)	-	Auftrieb m, Schwimmvermögen n, Schwimmkraft f
carbon dioxide (···dai'ɔksaid)	-	Kohlendioxyd n, Kohlensäure f

collide, to	-	zusammenstossen
collision	-	Zusammenstoss m, Kollision f, Anprall m
communicating tubes	-	kommunizierende Röhren f/pl
communicating vessels	-	verbundene Gefässe n/pl
density	-	Dichte f
diaphragm ('daiəfræm)	-	Membran (e) f, Diaphragma n, federnde Platte, Schwingwand f, Zwischenwand f; Lichtblende f
hot-air engine	-	Heissluftmotor m
immerse, to	-	(ein) tauchen, tränken
liquefaction of gas	-	Gasverflüssigung f
petrol engine	-	Benzinmotor m, Vergasermotor m
punch, to	-	lochen (Band); durchstossen; ausschneiden (stanzen)
to punch holes	-	lochen, (Löcher) ausstanzen
scattered	-	gestreut, zerstreut, diffus
sinker	-	Senkkörper m, Senker m, Senkblei n
sliding	-	Gleiten n, Rutschen n
specific gravity	-	Dichte f, Wichte f, spezifische Gravität
sulphur dioxide ('sʌlfə ···)	-	Schwefeldioxyd n
steam engine	-	Dampfmaschine f, Lokomotive f
store, to	-	speichern, einlagern
upthrust ('ʌp'θrʌst)	-	Auftrieb m, nach oben gerichtete Auflagerkraft

GRAMMAR and NOTES

1. Gases expand when they are heated -
   Gases expand when heated
   Archimedes discovered the upthrust while he was taking a bath -
   Archimedes discovered the upthrust while taking a bath.
   Nach den Konjunktionen when and while kann man das Personalpronomen sowie das Verb to be auslassen, wenn der ganze Satz durch das gemeinsame Subjekt verbunden ist. Siehe auch S. 136 u. 151 - Verbundenes und unverbundenes Partizip.
2. The light swift molecules of hydrogen on an average hit just as hard as the slow heavy ones of chlorine.

   One als Stützwort (prop-word) beim Adjektiv.

   Nach Adjektiven steht unbetontes one (im Plural: ones) stellvertretend für ein vorangegangenes Substantiv, das aus stilistischen Gründen nicht wiederholt werden soll.

   Weitere Beispiele:

They had to do an oral exercise, not a written one	Sie hatten eine mündliche Uebung zu machen, keine schriftliche
I don't like these vases. I want larges on not small ones	Diese Vasen gefallen mir nicht. Ich möchte grosse, keine kleinen

Entsprechend seiner Herkunft (Als Abschwächung des gleichlautenden Zahlworts) kann one nur in Beziehung auf zählbare Dinge oder Begriffe gebraucht werden.

I want large ones,

Es steht daher im allgemeinen nicht in bezug auf Stoffnamen:

He prefers white wine to red.	Er zieht weissen Wein dem roten vor.

Sinngemäss wird one aber verwendet, sobald die Setzung des unbestimmten Artikels den Stoffnamen in eine Sortenbezeichnung verwandelt:

He prefers a white wine to a red one.	Er zieht Weisswein dem Rotwein vor ("einen weissen Wein einem roten").

Ebenso steht das Stützwort nach Komparativen:

I don't like this hat. Can you show me a better one ?	Dieser Hut gefällt mir nicht. Können Sie mir einen besseren zeigen ?

Superlative stehen dagegen in der Regel ohne one :

We may distinguish several types. The simplest and the most frequent is	Wir können mehrere Typen unterscheiden. Der einfachste und häufigste ist ....

Gelegentlich wird das Stützwort one aber auch nach Substantiven gesetzt, die attributiv (wie Adjektive) verwendet werden. Hierzu zählen Fälle wie die folgenden:

leather shoes or rubber ones	Leder-oder Gummischuhe
a wooden fence or an iron one	ein Holz-oder ein Eisenzaun

Als Stützwort wird one nicht nur in Beziehung auf ein vorausgehendes Substantiv benutzt. In bestimmten Fällen wird es, ähnlich wie man, woman, person, people, nach Adjektiven zur Bezeichnung von Einzelpersonen (seltener Einzeldingen) verwendet, hat dann aber gewöhnlich einen gewissen Gefühlswert (Ausdruck der Zuneigung oder Abneigung):

He was one of the lucky ones.	Er war einer der Glücklichen.

3. Liquid - Flüssigkeit. Flüssige Körper (liquids) haben keine bestimmte Form, aber ein bestimmtes Volumen (definite volume).

Fluid - Flüssigkeit (a flowing substance); in der Physik und Chemie kennzeichnet sowohl Flüssigkeiten als auch Gase (a state of matter, e.g. a gas or liquid).

Solid bodies - Feste Körper haben eine bestimmte Form und ein bestimmtes Volumen.

Gases - Gasige Körper haben weder eine bestimmte Form noch ein bestimmtes Volumen.

4. C.G.S. (cgs) system = CGS-System n (physikalisches Massystem, basierend auf den Einheiten Zentimeter - Gramm - Sekunde)

5. Word Study

a) Collision (in nuclear science) - close approach between two particles, or photons etc. giving rise to an interchange of energy (Kollision);

(in physics) - the removal of electrons from an atom through collision with another particle (Stossionisation).

The act of colliding, or coming together with sudden, violent force.

A clash or conflict of opinions, interests, etc.

to collide - zusammenstossen
collision cross section - Stossquerschnitt m

collision damping	-	Stossdämpfung f, Dämpfung f durch Stösse (Spektrallinienbrei
collision excitation	-	Stossanregung f (von Gasmoleküle
collision frequency	-	Stosszahl f (pro Zeiteinheit)
collision integral	-	Stossintegral n
collision ionization	-	Stossionisation f
collision mean free path	-	mittlere freie Stossweglänge
collision number	-	Stosszahl f
collision of the first kind	-	Stoss m erster Art
collision of the second kind	-	Stoss m zweiter Art
collision probability	-	Zusammenstosswahrscheinlichkeit f
collisional damping	-	Stossdämpfung f, Dämpfung f durch Stösse
collisional excitation	-	Stossanregung f
collisional multiplication	-	Stossvervielfachung f
anticollision	-	Antikollisionsgerät n (the prevention of collision in the course o movements by ships or aircraft)
anticollision radar	-	Antikollisionsradar n
b) to scatter	-	(zer) streuen
scatter	-	Streuung f ; Streuecho n (Radar)
scattered	-	gestreut, zerstreut, diffus
scattered light	-	Streulicht n, zerstreutes Licht
scattered X-rays	-	Röntgenstreustrahlung f
scatterer	-	Streusubstanz f
scattering	-	Streuung f
scattering angle	-	Streuwinkel m
scattering power	-	Streuvermögen n

6. Some Symbols for

a) Fluid Properties

bulk modulus	K
conductivity, thermal	$\lambda \ldots k$
conductivity, thermometric; thermal diffusivity	k
density (mass/volume)	ρ
energy of gas, internal	U, E
energy of gas (internal), specific (energy/mass)	u, e
energy of liquid /weight (see head, under h)	
enthalpy	H.... I
enthalpy, specific (enthalpy/mass)	h.... i
entropy	S
entropy, specific (entropy/mass)	s
gas constant, molar (universal)	$\mathbf{R}$, R
gas constant, specific (characteristic)	R, $\mathscr{R}$
heat capacity, molar	C
at constant pressure	C_p
at constant volume	C_v
heat capacity, specific (often called specific heat)	c
at constant pressure	c_p
at constant volume	c_v
ratio of specific heat capacity at constant pressure to that at constant volume	γ
Knudsen number, λ/l	(Kn)
path, mean free	$\lambda \ldots l$
Prandtl number, $c_p \mu/k$	(Pr) ...σ
pressure (general)	p, P
pressure, atmospheric	p_a, p_{at}
sound, speed of	a
specific volume, i.e. volume/mass	V_m, v
surface tension	γ, σ
thermal diffusivity (see conductivity, thermometric)	
viscosity, dynamic	η, μ
viscosity, kinematic	ν
weight density (weight/volume)	w
weight density, reciprocal (volume/weight)	V_w

b) Fluid Motion

area, cross-sectional	A
boundary layer thickness (general)	δ
boundary layer displacement thickness, in two-dimensional and axi-symmetric flow (only)	δ_1, δ
boundary layer energy thickness, in two-dimensional and axi-symmetric flow (only)	δ_3
boundary layer momentum thickness, in two-dimensional and axi-symmetric flow (only)	δ_2, θ
boundary layer shape parameter, in two-dimensional and axi-symmetric flow (only)	H
cavitation number $\frac{p_\infty - p_c}{\frac{1}{2}\rho V^2_\infty}$	σ
circulation	Γ, K
compressibility factor, subsonic, $(1 - M^2)^{1/2}$	β
compressibility factor, supersonic, $(M^2 - 1)^{1/2}$	B, β
fluid flow, mass rate of (mass/time)	$\dot{m}, \dot{M}$
fluid flow, volume rate of (volume/time)	$\dot{V} \ldots Q$
fluid flow, weight rate of (weight/time)	$\dot{W}$
Froude number, $v/(gl)^{1/2}$	$\|(Fr) \ldots F, F_n$
Grashof number $\frac{l^3 g (T_1 - T_0)}{\nu^2 T_0}$	(Gr)
head, hydraulic (general)	h
head, friction	h_f
head, potential	z

head, pressure	h_p
head, velocity	h_v
head, total, of liquid $(z + h_p + h_v)$	H
Mach angle	μ
Mach number v/a	(Ma) ... M, M_n
pressure, total	p_0, p_t, P_0, P_t
pressure coefficient	C_p ... C_p
Reynolds number vl/ν	(Re) ... R, R_n
shear stress in fluid	τ
source strength (see fluid flow)	
Stanton number (a form of non-dimensional heat transfer coefficient), $h/\rho v c_p$	(St) ... C_h, k_h
strain, component of rate of	e (with appropriate subscript)
stream function	ψ
stress, component of	p (with appropriate subscript)
surface friction coefficient, local	c_f
surface friction coefficient, overall	C_f
temperature, total (absolute)	T_0, T_t
turbulence, correlation coefficients or velocity covariances	R (with subscripts)
turbulence, scale of	l, L
turbulence, micro-scale; dissipation length	λ
turbulence wave number	κ
velocity	V, v
velocity, friction (shear velocity)	U_τ, v
velocity, potential	ϕ
velocity potential, complex	w
vortex strength	Γ, K
vorticity	ω

EXERCISES

1. Put into the Passive Voice:

We usually refer to these changes as Verner's law. They were checking all the data. We must never depart from this principle. We have not thought of this drawback. They are now promoting large computers for literature search work. We congratulated the authors on their excellent contribution to the study of the subject. We have made every effort to utilize suggestions and comments for the improvement of the book. They should give these shortcomings proper attention.

2. Translate into German:

Einstein found that he had to make a radical departure from the astrophysics of Newton. Until recently it was assumed that experimental observations could reveal the laws of nature. At that time physicists realized that it was impossible to measure accurately. Gradually it became obvious that great differences of opinion had developed in regard to the interpretation of the phenomenon. The author suggested that the scheme offered great potentialities. It was announced that preliminary tests would be carried out within two weeks. It appeared that some of the previous arrangements would have to be cancelled.

3. Translate into English:

1) Die Beleuchtung war die beste, die er je gesehen hatte.
2) Der Zug um fünf Uhr zehn ist der beste.
3) Ist dies Zimmer das deines Bruders oder dein eigenes ?
4) Ziehen Sie englische Apparate den amerikanischen vor ?
5) Mir gefallen englische Romane besser als französische.
6) Es gibt hierauf eine richtige Antwort und eine falsche.

HEAT

Nature of Heat

Heat has much to do with molecular motion. From the fact that it is able to melt ice, vaporize water and cause bodies to expand. we may well suspect that it is at least closely related to some form of energy. A moving train or automobile loses its kinetic energy when the brakes are applied; but an examination of the brakes and wheels will show that energy has been converted into heat. On the other hand, heat is constantly used in engines for hauling trains, running machinery, and performing work in many other ways. Therefore, the conclusion is that the heat energy is a form of energy.

Heat a Form of Energy

The statement that heat is a form of energy raises the question: What form of energy is heat? In mechanics, we classified energy as either kinetic or potential. To which of these classes does heat belong?

Let us consider some of the ways in which heat is produced from mechanical energy. The molecules forming a nail are, we believe, in motion. When the head of the nail is struck by a hammer, the top layers of molecules receive the first impulse and move with greater speed, that is, their kinetic energy is increased; but, owing to the frequency of collisions between molecules, the motions are entirely at random, and the particles dash around in all possible directions. Part of the increase of kinetic energy is handed on by impact to the next layers, and so on. Much the same thing happens when the body is rubbed by another. This suggests that heat is kinetic energy of the particles of a body.

But we have seen that there are forces between the particles of a body, as shown by the properties of cohesion, elasticity, etc., and, when work is done against forces of attraction or repulsion, potential energy is produced. Hence changes in the potential energy of the particles of a body must accompany changes in their kinetic energy. Potential might not, it is true, affect the sense of touch in the same way as kinetic energy would, but, since we cannot separate it from the kinetic energy of the particles, we must let it go into the same account and consider it as part of what we call heat. Gases consist of particles which exert such feeble forces on one another, except at impact, that the potential energy is usually negligible. For this reason we shall see that gases play a particularly important part in the study of heat.

Let us now consider what we mean by "particles". We know that all bodies consist of molecules, and these of atoms, and further that the atoms contain electrons, and that these are also free electrons temporarily separated from atoms and molecules.. Moreover, in many bodies molecules are probably united in aggregates forming larger particles.

All these various particles receive kinetic and potential energy when a body is heated, and, without distinguishing between them in any way, we may say that their total increase of kinetic and potential energy constitutes the increase of heat.

We must, however, distinguish the motions of a body as a whole, or its "mass motions" from the " random motions" of the particles. In the former all the particles move in the same way (as in translation) or in some regular way (as in rotation), and, as we have seen, the energy of this motion can be calculated. It is the energy of the motion of the particles in random directions that constitutes heat. A gas or liquid flowing at a high speed in a pipe does not possess more heat because of its mass motion, though by impact of the particles on the surface of the pipe part of this motion may be turned into the random motion that constitutes heat. Similarly a current of electricity in a wire consists of a stream of electrons in the wire, but this also does not constitute heat, although it may give rise to heat. For the same reason, wave motions of the particles in a body do not constitute heat.

With these explanations we may regard heat as the kinetic energy of the irregular motions of the particles of a body and the potential energy associated with it.

Temperature. - The most familiar temperature is that of the human body. Objects are said to be warm, hot, cool, or cold compared with this temperature. This is not a very reliable or accurate standard. Therefore it is necessary to look for some more accurate method of estimating temperatures. For this purpose it is customary at ordinary temperatures to use a thermometer, which depends for its operation on the fact that a liquid like mercury expands when its temperature is increased. The most common type of thermometer for ordinary use is the mercury-in-glass thermometer.

Fixed points. - The two fixed points that are ordinarily chosen for a thermometer are the melting point of ice and the boiling point of water under atmospheric pressure.

Comparison of Centigrade and Fahrenheit Thermometers.

One hundred degrees on the centigrade scale correspond to 180 on the Fahrenheit scale, and 1° on the Fahrenheit scale equals five ninths of 1° on the centigrade.

Reading on centigrade = 5/9 (reading on Fahrenheit) - 32°

Reading on Fahrenheit = 9/5 (reading on centigrade) + 32°

Unit of Heat. - Although heat is a form of energy and may be measured in the units in which energy is measured, it is convenient to use a unit that is based on the effect of heat in raising the temperature of a substance. The unit of heat in the cgs system is called the *calorie*. It is defined as the quantity of heat or energy which is necessary to raise the temperature of 1g of water from 15° to 16° on the centigrade scale. Because of the fact that the heat required to raise the temperature of 1g of water 1° C is not the same at all temperatures, it is necessary to state the temperature at which the calorie is defined.

The British Thermal Unit. - In the

English system of units, the unit of heat is known as the British thermal unit (Btu). It is defined as the quantity of heat required to raise the temperature of 1 lb of water from 59° to 60° on the Fahrenheit scale. This is a much larger unit of heat than the calorie. Here, as in the case of the calorie it is necessary to state the temperature, for the amount of heat required to raise 1 lb of water 1° F varies with the temperature.

Specific Heat.- The amount of heat required to raise the temperature of 1g of another substance 1° C may be compared with the amount of heat required to raise the temperature of 1g of water from 15° to 16° C. Such a comparison gives a definition of what is called the specific heat of the substance. The specific heat of a substance is numerically equal to the number of calories required to raise the temperature of 1g of the substance 1° C, or, what amounts to the same thing, the number of British thermal units required to raise the temperature of 1 lb of the substance 1° F.

Heat of Combustion.- The heat of combustion is the heat liberated by burning unit mass or unit volume of a fuel such as coal or gas.

$$\text{Heat of combustion} = \frac{\text{mass of water x temperature change x specific heat}}{\text{mass of fuel}}$$

In this expression for the heat of combustion, it is assumed that the water equivalent of the calorimeter is so small that it can be neglected in comparison with that of the water in the calorimeter. In case this is not true, the water equivalent of the calorimeter must be added to that of the water in the calorimeter.

FUSION

The Melting Point.- If a vessel of ice or snow is heated, the temperature at first rises until it is 0° C and then remains stationary until all the ice is melted. After all the ice has been melted, the temperature of the water begins to rise. That temperature at which the solid changes into a liquid without a change of temperature is called the melting point. For ice this temperature is 0° C or 32° F. At the melting point,the addition of heat simply serves to hasten the melting process without any change of temperature.

If a pail of water is placed in a freezing mixture of ice and snow, the temperature of the water decreases until ice begins to be formed in the pail. After this temperature has been reached, the temperature of the water in the pail remains the same until all the water has become ice. That temperature at which the liquid changes into the solid state is its freezing point.

Heat of Fusion.- The heat of fusion of a substance is defined to be the number of calories necessary to convert 1g at the melting point into liquid at the same temperature. It may also be defined as the number of Btu that must be supplied to change 1 lb of the solid to liquid without a change of temperature.

Effect of Pressure on the Melting Point.- Since an increase of pressure tends to cause a body to contract, the melting point of ice, which contracts on melting, is lowered by the application of pressure. Careful experiments show that this lowering is 0.0075° C for an increase of 1 atm of pressure. If, on the other hand, a substance expands upon melting, its melting point will be raised by the application of pressure.

Boiling Point of Water.- The boiling point can be defined as the temperature at which the vapour pressure of a liquid becomes equal to the pressure exerted on the liquid by the surrounding atmosphere. At this temperature bubbles of vapour can sustain themselves inside the liquid and grow.

Effect of Pressure on the Boiling Point.- Since the boiling point of a liquid is the temperature at which the vapour pressure of the liquid is the same as the outside pressure on it, it follows at once that when the outside pressure is changed, the boiling point will also change.

Transfer of Heat

Convection.- The simplest way in which heat may be transferred from one place to another is by the motion of the heated substance. Such a transfer is known as convection. It is caused by the change in density that takes place when the substance is heated. For example, when a gas or a liquid is heated, it expands and becomes lighter than the cold gas or liquid. When water is heated in a vessel on a stove, the liquid in the bottom of the vessel is hotter than that on the top. The density at the bottom is less than that near the top. The cool liquid sinks down and forces the warmer liquid to a higher level. The currents of water thus set up in the liquid are known as convection currents.

Conduction.- When a metal rod is held in the fire, the heat travels along the rod and after a time the rod becomes too hot to hold. In this process the vibrations of the molecules are handed on from molecule to molecule. The layer of molecules in contact with the fire is heated first and thus made to vibrate more rapidly. This layer hands the motion on to the adjacent layer, because each layer is bound to the adjacent layer by certain cohesive forces. It is thus impossible for the molecules in one layer to vibrate without setting the molecules in the neighbouring layers in vibration. As this process goes on, the entire medium is heated after a time. When heat, as in this case, is transferred from one part of the body to another without any progressive motion of the parts of the substance, the heat is said to be transferred by conduction. The conductivity differs widely according to the nature of the substance. Steam pipes are covered to reduce heat losses.

Effect of Temperature on Thermal Conductivity.- The thermal conductivity of carbon increases with the temperature. On the other hand, the thermal conductivity of metals decreases with an increase of the temperature. The thermal conductivity changes abruptly when a substance like sulphur changes from one crystalline state to another.

Transfer of Heat by Radiation.- A person sitting in front of a stove receives heat from the stove, although the air in the room is cold. This method of transfer of heat is distinguished from convection and conduction by the fact that the medium through which the transfer occurs is not heated. Thus the earth receives great quantities of heat from the sun, although the space that separates the sun from the earth is very cold. The fact that the earth receives such quantities of heat from the sun shows that this heat can pass through the empty space between the sun and the atmosphere that surrounds the earth. When this energy reaches the earth, it causes the molecules of the body on which it falls to vibrate more rapidly, and the body is heated. This movement of heat from one place to another is known as transfer of heat by radiation. It is a twofold process: the conversion of the heat energy of the hot body into a transverse wave motion, and a reconversion of the wave motion into heat by the body on which it falls.

Heat and Work.- Heat is the energy that a body possesses by virtue of the fact that its molecules are in motion. In solids they do not alter their relative positions greatly, but vibrate back and forth through positions of equilibrium. If two sticks are rubbed together vigorously, they become hot. Drills or augers become too hot to hold in the hand when used to bore hard wood or metal. In all such cases, work is done on the body, and heat is developed in consequence of this work.

Mechanical Equivalent of Heat.- Since work is a form of energy, it may be converted into heat. According to the law of conservation of energy, it is not possible to create or to destroy energy. Hence, a definite quantity of work is required to produce a given amount of heat. Experiments have shown that this amount of work is the same under all conditions. Mechanical equivalent of heat is defined as the number of units of work necessary to generate one unit of heat. In the metric system it is the number of gram-centimeters or kilogram-meters or ergs required to develop 1 cal.

Transformation of Heat into Work.- The heat engines that play such a large part in modern life depend on the transformation of heat into work. The heated steam in the cylinder of a steam engine does work in pushing the piston back. This work is available for driving the machinery connected to the engine. A gasoline engine can drive an automobile only when it is supplied constantly with heat from the exploding gasoline in the cylinders. In these cases, heat is transformed into work.

First Law of Thermodynamics.- The first law of thermodynamics is a special case of the law of conservation of energy. It is implied in the definition of the mechanical equivalent of heat and may be expressed by the equation

$$W = JH$$

where W = the work measured in work units
H = heat measured in heat units
J = the mechanical equivalent of heat

More specifically, the law states that when any mechanical change occurs in an isolated system, the energy of the system remains constant. Heat may be transformed into work or work into heat, but the total energy of the system remains unchanged. In other words, the first law of thermodynamics states that in the transformation of work into other forms of energy or in the transformation of one form of energy into other forms of energy, no energy is ever created or destroyed. The energy before and after the transformation is always the same. This law in its general form can not be proved by experiment but conclusions based on it have always been confirmed by experiment.

Second Law of Thermodynamics.- The second law of thermodynamics states the conditions under which heat may be transferred from one body to another. It is in effect a statement of the fact that heat naturally flows from a place of higher to one of lower temperature but never in the reverse direction. An analogue may make the meaning clearer. Water may flow from a higher to a lower level with the performance of work. Heat may flow from a higher to a lower temperature with the performance of work. To cause water to flow from a lower to a higher level requires that external work be done on it. To cause heat to flow from a lower to a higher temperature also requires the performance of external work. The natural tendency of heat to flow from a higher to a lower temperature makes it possible for a heat engine to transform heat into work. On the contrary, a mechanical refrigerating machine must transfer heat from a colder to a hotter body. Work must be done on such a machine to make this transfer. The following is one form of statement of the law:

It is impossible for any kind of a machine working in a cycle to transfer heat from a lower to a higher temperature unless external work is done on it.

The law cannot be proved by direct experiment. It is a generalization based on the fact that in all human experience no contradictions of the law have been found. It merely states that heat of itself can flow only from higher to lower temperatures and no exceptions to this rule are known.

Efficiency.-Since heat and work are convertible, the most important thing to know about any device for this purpose is its efficiency, which gives a measure of the amount of heat which can be transformed into work under a given set of conditions. The ratio of the work obtained from the machine to heat put into it is called the efficiency of the machine. Both the heat and the work must be measured in the same units. The efficiency may be defined as the fraction which tells what portion of the total heat supplied is used for the purpose for which it was intended.

$$\text{Efficiency} = \frac{\text{heat used}}{\text{heat supplied}}$$

Energy Transformation. Varieties of Energy.- There exist many sources of energy in the world both potential and kinetic. A very important matter is the conversion of energy from one form to another. The form most required by us is mechanical energy. Appliances for converting energy from one form to another are called engines. Thus a heat engine is a machine for converting heat into mechanical energy by the combustion of coal or oil and a water engine (water turbine) can convert the kinetic energy of falling water into mechanical energy. Another important matter to all such engines and transformation is the question of their efficiency or the ratio of the energy delivered in the desired form to that given to the engine in the available form.

QUESTIONS

1) Why do two pieces of ice melt when rubbed against each other?
2) How may heat be transferred from one place to another?
3) What form of energy is heat?
4) What does the letter J stand for in thermodynamics?
5) Are metals good conductors of heat?
6) How can we prevent heat from escaping?
7) Has coal a high heating value?
8) What are calorimeters used for?
9) What is the dew point?
10) What do we call the unit of heat in the cgs system? in the English system?
11) How can be defined the boiling point of water?

IMPORTANT TERMS

auger ('ɔːgə) - Bohrer m, Erdbohrer m, Holzbohrer m, Schneckenbohrer m

bar - Stab m, Stange f, Stabstahl m, Traverse f, Profilstange f; Bar n (physikalische Einheit)

bottom - Boden m, Grund m; Basis f
at (in, on) the bottom of the vessel - im untersten (tiefsten) Teil des Gefässes
bubble - Blase f
centigrade scale - 100-Grad-Skala f, Celsius-Skala f
dash, to - schlagen, heftig stossen, schleudern, werfen
dew point - Taupunkt m (Luftfeuchtigkeit)
haul, to (hɔːl) - befördern, transportieren, ziehen
heat of combustion - Verbrennungswärme f
heat of fusion - Schmelzwärme f
impact - Stoss m, Anstoss m, Schlag m, Zusammenstoss m
law of conservation of energy - Gesetz n von der Erhaltung der Energie
lower, to - senken, abwärtsbewegen, herablassen
melting point - Schmelzpunkt m
mercury thermometer - Quecksilberthermometer n
metal bar - Metallstange f
metal rod - Metallstange f, Rundstahl m
nail - Nagel m
pail - Eimer m, Kübel m
a pail of water - ein Eimer (voll) Wasser
piston - Kolben m
random, at - willkürlich, zufällig, ziellos
rod - Stange f, Rundstange f, Rundstab m, Draht m; Rute f (Längenmass, 5 ½ Yards)
thermal conductivity - Wärmeleitfähigkeit f, thermische Leitfähigkeit
vaporize, to - verdampfen, verdunsten
vessel - Gefäss n, Behälter m; Schiff n; Hohlkörper m

GRAMMAR and NOTES

1. According to the law of conservation of energy, it is not possible to create or destroy energy.
   Every machine wastes energy because of friction. When the sun emits radiation, its mass decreases because of the decrease of energy due to radiation.
   ... but owing to the frequency of collisions between molecules, the motions are entirely at random.

   Der Form nach lassen sich die Präpositionen einteilen in

1) einfache wie at, by, for, from, in, on, of, to, with; ebenso spätere Ableitungen wie concerning, during, past;

2) zusammengesetzte, und zwar

   a) aus zwei Präpositionen, z.B.: into, upon, without;
   b) aus Präposition + Substantiv, z.B.: amidst (on + mid-st), beside (by + side), outside;
   c) präpositionale Fügungen, vor allem aus Präposition + Substantiv + Präposition, z.B.: by means of, in spite of, for fear of, instead of, on account of; aus Adjektiv (oder Partizip) + Präposition, z.B.: owing to, according to, close to, next to.

Zur Verwendung

Die Präpositionen sind als wichtigste Funktionswörter für die analytische Satzgliedverknüpfung im Englischen von grösster Wichtigkeit.

Die Beziehung zum Adverb ist im modernen Englisch enger als im Deutschen. Die Mehrzahl der als Präpositionen gebrauchten Wörter wird unverändert auch als Adverbien verwendet.

Vgl. etwa

Will you look after this matter?	Wollen Sie sich darum kümmern?
after three years	nach drei Jahren

mit

What comes after (=next)?	Was kommt danach?
three years after (=later)	drei Jahre danach (=später).

Wegen der Auflösung des früheren Kasussystems kann im Englischen von einer eigentlichen "Rektion" der Präpositionen (und Verben) nicht gesprochen werden. Alle Präpositionen verbinden sich mit dem Objekts- bzw. Einheitskasus:

Objektskasus:	Einheitskasus:
I was looking after / at / for him.	I was looking after / at / for my friend.

Die Präpositionen (einschliesslich to) können als Verbform nur das Gerundium (bzw. das Verbalsubstantiv) nach sich haben:

Thank you for coming.	Vielen Dank für Ihr Kommen!
I am looking forward to seeing you again.	Ich freue mich schon darauf, Sie wiederzusehen.

Nicht als Präposition anzusehen ist dagegen to als abgeschwächtes Funktionswort vor dem Infinitiv.
Die für das heutige Englisch wichtigsten und am häufigsten gebrauchten zusammengesetzten Präpositionen sind:

according to	-	gemäss, nach, laut
as to, as for	-	was...(an) betrifft, bezüglich
because of	-	wegen, infolge von (od.gen.)
by means of	-	mittels, durch
by reason of	-	wegen, infolge
by virtue of	-	kraft (gen.), auf Grund von (od.gen.) vermöge (gen.)

by way of - durch, (auf dem Weg) über, in der Absicht zu, um .... zu

due to - wegen, infolge

for the sake of - um...(gen.) willen, j-m zuliebe, wegen

in accordance with - in Uebereinstimmung mit, gemäss

in addition to - ausser (dat.), zuzüglich (gen.)

in consequence of - infolge von (od.gen.), wegen

in front of - vor, gegenüber

in relation to - in bezug auf (acc.)

in spite of - trotz, ungeachtet (gen.)

in respect of (od.to) - hinsichtlich (gen.), bezüglich (gen.), in Anbetracht (gen.)

in view of - im Hinblick auf (acc.), in Anbetracht od. angesichts (gen.)

in virtue of - auf Grund von (od.gen.), kraft (gen.), vermöge (gen.)

instead of - (an)statt (gen.), an Stelle von

on account of - um.....willen, wegen

out of - aus (...heraus), zu....hinaus, von (two out of three-zwei von drei Personen etc.), ausserhalb, ausser (Reichweite, Sicht etc.), ausser (Uebung, Atem etc.), ohne (Geld etc.), aus der Mode, Richtung, nicht gemäss etc., ausserhalb (5 Miles out of Oxford), (hergestellt) aus: made out of paper etc.

owing to - infolge (gen.), wegen (gen.), dank (dat.): to be owing to = zurückzuführen sein auf, zuzuschreiben sein (dat.)

thanks to - dank (dat., häufig mit gen.)

with regard (respect, reference) to - hinsichtlich, bezüglich, was....betrifft

2. ... made *from*, ... made *of*

That bridge is made *of* steel.	Die Brücke da ist aus Stahl.
Steel is made *from* iron.	Stahl wird aus Eisen hergestellt.

Um die *Umwandlung eines Materials* zu bezeichnen, steht *from* (und nicht *of*) nach *make*.

3.

vapour - Dampf m	(a gas the temperature of which is below the critical temperature; hence it can be liquefied by compression only, without temperature reduction being essential)
steam - Dampf m, Wasserdampf m	(water vapour at a temperature at or above the boiling point of water; by analogy the vapour of any liquid). Vaporized water is used for heating, cooking, cleaning, and, under pressure, as a source of power.

4. therm*o*meter, man*o*meter, bar*o*meter, *a*mmeter.
Längere Wörter nicht-germanischer Herkunft (z.B. Messinstrumente, die auf- meter enden), haben den Hauptakzent in der Regel auf der *drittletzten* Silbe (Ausnahme: *a*ltimeter ('æltimi: tə). Als Masseinheit (unit of measure) wird im britischen Englisch - met*re* geschrieben, z.B.: millimet*re*, centimet*re*.

5. It is thus impossible *for* the molecules in one layer to vibrate without setting the molecules in the neighbouring layers in vibration.
It is impossible *for* a single force *to produce* the same effect as a couple.
Um die im Infinitiv ausgedrückte Handlung auf einen vom

Satzsubjekt verschiedenen Handlungsträger zu beziehen, der nicht als direktes Objekt auftreten kann, wird die for-Konstruktion verwendet:

A. nach prädikativ gebrauchten Adjektiven:

I should be sorry for you to think that.	Es täte mir leid, wenn Sie das dächten.

Besonders auch in Verbindung mit too und enough:

The tea is too hot for me to drink.	Der Tee ist für mich zu heiss zum Trinken.
The noise is loud enough for anyone to hear.	Das Geräusch ist so laut, dass es jeder hören kann.
The kitchen is just big enough for you to have your meals in.	Die Küche ist gerade gross genug, dass man seine Mahlzeiten darin einnehmen kann.

Nach Adverbien, auch in Verbindung mit enough und too, ist die for-Konstruktion ebenfalls möglich:

I shall read the text slowly enough for you to write down.	Ich werde den Text so langsam vorlesen, dass Sie ihn aufschreiben können.

Die for-Konstruktion kann auch nach den Vergleichspartikeln as und than auftreten:

Is there anything more ridiculous than for him to do such a thing?	Gibt es etwas Lächerlicheres, als dass er so etwas tut?

Statt eines beziehungslosen it findet sich nach for gelegentlich auch unbetontes there:

It is impossible for there to be any more.	Es ist unmöglich, dass noch etwas da ist. Es kann unmöglich noch etwas dasein.

B. nach Substantiven oder unbestimmten Zahlwörtern wie some(thing), any(thing), enough (oft mit einleitendem here is, there is, it is, this is):

Have you got those letters for me to sign?	Haben Sie die Briefe zum Unterschreiben für mich da?
Here are some new words for you to remember.	Hier sind ein paar neue Wörter, die Sie (im Gedächtnis) behalten sollten.

C. nach Verben, die auch sonst mit for verbunden werden:

You must wait for her to accustom herself to the idea.	Du musst warten, bis sie sich an die Vorstellung gewöhnt hat.
What we were saying was not intended for someone else to hear.	Was wir da sagten, sollte nicht von jemand anders gehört werden.

Die for-Konstruktion findet sich (unter amerikanischem Einfluss) aber auch nach transitiven Verben an Stelle eines Objekts:

I could not bear for us not to be friends.	Ich könnte es nicht ertragen, wenn wir nicht Freunde wären.

D. häufig als Verkürzung von Finalsätzen, um Absicht oder Zweck auszudrücken:

She is bringing the photographs for you to see.	Sie bringt die Fotos mit, damit ihr sie euch ansehen könnt.
I will leave the papers here for you to read.	Ich werde die Papiere hierlassen, damit Sie sie lesen können.

6. Temperature Units.

In 1962, the Comité International des Poids et Mesures (CIPM) approved use of the degree Kelvin, with symbol $^{\circ}K$, to indicate

the unit both for a difference between two thermodynamic temperatures and for a thermodynamic temperature itself. At the same time it was considered that, if judged necessary, the international symbol "deg" could be used for the indication of an interval or a difference of temperature.

degree Kelvin	K (now K only)
degree Celsius	$^{\circ}C$
degree Fahrenheit	$^{\circ}F$
degree Rankine	$^{\circ}R$

7. Some Symbols for Physical Quantities

Quantity	Symbol
absorption factor	α
acceleration due to gravity .. .. (acceleration in free fall)	g
coefficients, miscellaneous	C (with appropriate subscript)
compressibility	κ
conductivity, thermal	$\lambda \ldots k$
cubical expansion, thermal coefficient of	γ, β
density (mass/volume)	ρ
diameter	d,D
diffusion coefficient	D
DIMENSIONLESS PARAMETERS	
Graetz number, $\dot{m}c/kl$	(Gz)
Grashof number, $\frac{\rho l^3 g(\Delta\rho)}{\eta^2}$	(Gr)
Mach number, v/a	(Ma)
Nusselt number, hl/k	(Nu)
Peclet number, $\rho v cl/k$	(Pe)
Prandtl number, $c_p \eta/k$	(Pr)
Rayleigh number, $\frac{l^3 \rho c g(\Delta\rho)}{\eta k}$	(Ra)
Reynolds number, vl/ν	(Re)
Stanton number, $h/\rho v c_p$	(St)

dryness fraction	x
eddy diffusivity	ϵ
efficiency	η
factors, miscellaneous (e.g. configuration factor)	F (with appropriate subscript)
flow rate*, mass (mass/time)	$\dot{m}, \dot{M}$
flow rate*, volume (volume/time)	$\dot{V} \ldots Q$
frequency of rotation	n, N
gas constant, molar (universal)	$\mathbf{R}, R_0$
gas constant, particular	R
gas constant, particular (for gas of molecular weight M)	R_M
gauge pressure	$p_g \ldots P_g$
Graetz number	(Gz)
Grashof number	(Gr)
heat flow rate (heat/time)	$\Phi, \dot{Q}$
heat flux intensity (heat/area x time)	ϕ
heat transfer, coefficient of (heat/area x time x temperature difference)	h, α
heat transfer, overall coefficient of	U, K
humidity, relative	ϕ
linear expansion, thermal coefficient of	α
mass velocity (ρU)	G
mean depth	m, h_m
molecular weight	M
Nusselt number	(Nu)
Peclet number	(Pe)
polytropic index	n
power	P
quantity of heat, aggregate	Q
quantity of heat divided by mass	q
ratio, by mass (in particular, dryness fraction)	x
ratio of specific heat capacity at constant pressure to that at constant volume	$\gamma \ldots k$

ratio, pressure	r_p
ratio, volume	r_v
ratios, miscellaneous	r(with appropriate subscript)
reflexion factor	ρ
relative humidity	ϕ
sensible heat	$Q_s \ldots q_s$
sound, speed of	a
specific heat capacity (often called 'specific heat')	c_p, c_v
specific volume	v
Stanton number	(St)
Stefan-Boltzmann constant	σ
temperature, absolute	T
temperature, empirical (customary temperature)	θ, t
thermal coefficient of cubical expansion	γ, β
thermal coefficient of linear expansion	α
thermal diffusivity	$a \ldots \alpha$
THERMODYNAMIC QUANTITIES	
enthalpy (total heat)	H
enthalpy, specific	h
entropy	S
entropy, specific	s
Gibbs function	G
Gibbs function, specific	g
heat capacities	C_p, C_v
heat capacities,specific	c_p, c_v
internal energy	U,E
internal energy, specific	u, e
latent heat, specific (often called "latent heat")	l(or alternatively expressed as an enthalpy difference)
volume	V
specific volume	v

total emissivity	ϵ
transmission factor	τ
velocity, linear	u, υ, w
velocity, angular	ω
vertical distance from datum	z
viscosity, dynamic	η, μ
viscosity, kinematic	ν
wavelength	λ
work	W...w

The significance of the symbols used in the definitive formulae is as follows:

Symbol	Quantity
a	sound, speed of
c	specific heat capacity
c_p	specific heat capacity at constant pressure
g	acceleration due to gravity
h	coefficient of heat transfer (heat/area x time x temperature difference)
k	conductivity, thermal
l	a reference length
$\dot{m}$	flow rate, mass
υ	velocity
η	viscosity, dynamic
ν	viscosity, kinematic
ρ	density (mass/volume)

*The dot placed above a symbol for rate may be omitted when the fundamental quantity, mass or volume, does not occur in the same context.

EXERCISES

1. Insert suitable prepositions:

The mechanical equivalent of heat is denoted......the letter J.

A calorimeter is provided......lagging. She forgot to switch ......the current. Acoustics deal......sound. Infra-red and ultra-short waves are near......frequency. The inertia of a moving train prevents it......stopping as soon as the brakes are applied. The radius of a circle bisects a chord......right angles. The voltage......a conductor varies as the current ......it. The current lags......the voltage, it is......phase. The static moment......a point is the product of the force and the perpendicular distance. Form sentences......the following words. Change the following sentences......questions and answer them. A table is usually made......wood. Paper is made......wood.

2. Form sentences by using the construction for + object + infinitive:

Scientific workers must have a thorough knowledge of English (it is necessary). Postgraduate students were to continue their studies (a scholarship was offered). The readers will save time (a detailed bibliography is added to the book). People will receive a good knowledge of English literature (a series of lectures will be held).

3. Translate into German:

1) For an observation to be of service two facts must be known.
2) This is the normal state for a body to be in.
3) For language to operate efficiently there should be little conscious effort.
4) It is necessary for them to admit that they have made a mistake.
5) On obtaining particularly bad results it is natural for a student to attribute the error to some purely mechanical defect.

4. Translate into English:

1) Der Apparat ist für Sie zu schwer zum Anheben.
2) Das Auto brauchte zwei Stunden, um den Bahnhof zu erreichen.
3) Hier sind ein paar neue Fachwörter, die Sie im Gedächtnis behalten sollten.
4) Er wünschte, dass die Unterredung zu Ende ginge.
5) Es liegt mir sehr daran, dass es sofort getan wird.

Lesson Eleven

SOUND

Wave Motion and Sound

Wave Motion.- One of the most important phenomena in nature is the transmission of energy from one point to another by wave motion. This kind of motion is illustrated in many ways. When a stone is dropped into a pool of still water, the surface of the water is covered with circular wavelets which widen out from the central point where the stone fell. The water does not really move outward from the central point, but it rises and then falls again. That such is the case is seen by observing a floating leaf or piece of wood. It does not move forward but returns again and again to its former position. Hence, the water on which the leaf rests must have this same kind of upward and downward motion rather than a forward motion.

When one end of a rope is fastened to a rigid wall and the free end moved up and down rapidly, each jerk travels along the rope, each portion of the rope communicating the jerk to the next portion. Each particle of the rope imparts its upward or downward motion to its neighbours. The jerk moves forward, but the particles of the rope move only up and down. Motions of this kind are wave motions. In all these cases it is evident that there is a vibrating center which produces motions in those portions of the medium immediately in contact with it, and that these portions impart their motions to the neighbouring portions.

Transverse Waves.- If part of a stretched string is drawn aside, the tension in the string tends to bring it back to its position of equilibrium. Since the string has inertia, the force that causes the displacement requires time to produce its full effect so that a wave can travel along the string with a definite velocity. Waves of this kind are easily produced in a rope fixed at one end and held in the hand at the other. If the rope is lightly stretched, a jerk imparted to the end B travels down the rope as a wave. The more tightly the rope is stretched, the more rapidly the jerk travels down it. If a series of to-and-fro movements is imparted to the end B, a series of waves travels down the rope. Such waves are known as transverse waves, because the particles of the medium in which the waves travel move perpendicular to the direction of the wave motion. They can be easily represented by plotting the displacements on the vertical axis and the distance from the source in a given direction on the horizontal axis. Light and other forms of electromagnetic waves are excellent illustrations of transverse waves.

Compressional and Longitudinal Waves.- A wave in an elastic medium which causes an element of the medium to change its volume without undergoing rotation is called compressional wave.

A wave in which the direction of displacement of each particle in the medium is perpendicular to the wave front is called longitudinal wave.

Sound waves are longitudinal waves. The molecules of the medium in which the sound travels move back and forth in the direction of the propagation of the sound.

Production and Transmission of Sound.

Nature of Sound.- The source of sound is always in a state of vibration. As the vibration dies down, the intensity of the sound diminishes. If a ringing bell is touched with the fingers, the sound ceases because the vibrations are stopped by the fingers. When a weight falls to the floor, the weight as well as that part of the floor which is struck are set in vibration, and sound waves are produced. If a stretched guitar string is plucked, it gives a musical note owing to the vibrations set up in it. These vibrations take place too fast for the eye to follow them, and the string seems to be drawn out into a ribbon in the middle. In a vibrating tuning fork the prongs alternately approach and recede from each other. These movements of the prongs can be felt by touching the prongs with the fingers. They produce compressions and rarefactions in the surrounding air that travel forward as sound waves.

Velocity of Sound.- The velocity of sound depends on the density and the elasticity of the medium. The greater the elasticity and the less the density, the greater is the velocity. The relation between the velocity, the density, and the elasticity of the medium is expressed by the formula

$$v = \sqrt{\frac{e}{p}}$$

where v = the velocity of sound
e = the modulus of elasticity of the medium
p = the density of the medium.

The Intensity of Sound.- When sound waves spread out in every direction from a source of sound, the intensity varies inversely as the square of the distance from the source. In this case, the sound waves spread out as spheres. The same amount of energy is transmitted across every spherical surface having its center at the source of sound. The larger the surface of these spheres, the smaller the energy that goes through each square centimeter of surface. The surfaces of these spheres increase as the squares of their radii. Hence, the energy that passes through unit area decreases as the squares of the radii increase.

Velocity of Transverse Waves in Strings.- The velocity of a transverse wave along a flexible stretched string is constant for a given tension. Whatever the nature of the wave, its velocity of propagation is the same so long as the tension is unchanged.

Noise.- By noise is understood sound consisting of a mixture of airborne vibrations which is completely irregular with regard to sound intensity, frequency and phase. Noise is usually regarded as a nuisance and may, if the sound intensities involved are very high, cause damage to the organs of hearing. To provide protection against noise is an important function of modern structural engineering. According to the Weber-Fechner law of hearing, the apparent loudness of a sound-i.e., the intensity of the acoustic perception-is approximately proportional to the logarithm of the intensity of the stimulus (sound intensity). The unit of objective loudness or sound level is the phon. The loudness (in phons) of a sound is equal to the intensity in decibels of a sound of frequency 1000 cycles/sec. which seems as loud to the ear as the given sound. Loudness values in excess of 130 phons produce a sensation of acute discomfort. Continuous noise in excess of 100 phons may cause hearing damage. The sound-level scale from 1 to 140 phons comprises the intensity ratio of $1:10^{14}$. Objective measurement of sound intensity can be carried out by means of a Rayleigh disc.

Sound Barrier.- The speed, or velocity of sound is the speed at which a disturbance is propagated through a substance. It depends on the elastic properties and density of the substance concerned. In air at normal atmospheric pressure, at a temperature of 15° C, sound travels at a speed of 340 m/sec. So long as the speed of an aircraft travels at a speed below the speed of sound, the air will be displaced in all directions and behave as an entirely "soft" medium. When the aircraft reaches the speed of sound, however, the air becomes "hard" and presents a very high resistance- the "sound barrier" - which the aircraft must break through or, rather, slice through. On going through the barrier, the aircraft produces a series of elastic waves in the air. As they travel at a slower speed, these waves lag behind the aircraft. The transition from supersonic to subsonic air flow is accompanied by a shock wawe.

QUESTIONS

1) What do we call wave motions?
2) What are excellent illustrations of transverse waves?
3) On what does the velocity of sound depend?
4) What are compressional waves? longitudinal waves?
5) By what formula is expressed the relation between the velocity, the density, and the elasticity of the medium?
6) What is source of sound?
7) By what means can be carried out objective measurement of sound intensity?

8) What is reverberation?
9) What do you hear when you listen to two sounds near in frequency?
10) What is understood by noise?
11) How do we provide protection against noise?
12) What is the unit of objective loudness or sound level?
13) What do we understand by sound barrier?

IMPORTANT TERMS

acoustic perception	- akustische Empfindung
airborne	- luftübertragen, von der Luft getragen, luftbefördert, Bord...(in Zusammensetzungen)
die, to (down)	- abklingen, ausschwingen
discomfort	- Unannehmlichkeit f, Unbehagen n, Unwohlsein n
disturbance	- (atm.) Störung f, Funkstörung f, Störgrösse f; (radio) Störgeräusch n
equilibrium	- Gleichgewicht n; Ausgleich m; Ruhelage f
excess	- Ueberschuss m, Uebermass n
in excess of (demand)	- mehr als (benötigt)
to be in excess of something	- etwas übersteigen od.- schreiten, über etwas hinausgehen
impart, to	- erteilen, ausüben, vermitteln, zugänglich machen, mitteilen
to impart pressure to	- unter Druck setzen, Druck ausüben auf
jerk (dʒəːk)	- Ruck m, ruckartige Bewegung, plötzlicher Stoss
jerk movement	- ruckweise Bewegung
lag, to (behind)	- nacheilen, zurückbleiben (Phase)
lag	- (el.) Nacheilung f, Nacheilen n (des Phasenwinkels), Verzögerung f (Relais); Zurückbleiben n; Verzug m; Nachhinken n; Dämmstoff m
loudness	- Lautheit f, Lautstärke f
loudness level	- Lautstärke f
loudness level meter	- Lautstärkemesser m
loudness scale	- Lautstärkeskala f

nuisance (ˈnjuːsns)	Lästigkeit f, Aergernis n, Plage f, Pest f
nuisance area	(el.) Störgebiet n, Interferenzzone f; (radar) Verwirrungsgebiet n
organ of hearing	Gehörorgan n
plot, to	auftragen, aufzeichnen, (ein)zeichnen, eintragen, diagrammatisch darstellen; orten; planen
to plot a curve	eine Kurve zeichnen
to plot a line	eine Linie trassieren
to plot against	auftragen über
pluck, to	ziehen, zerren, reissen, zupfen
plucked chord (string)	gezupfte Saite
prong (prɔŋ)	Gabel f, Zinke f, Zacke f; (el.) Steckerstift m, Kontaktstift m
rarefaction (ˌrɛəriˈfækʃən)	Verdünnung f
rarefaction of air	Luftverdünnung f
recede, to	zurücktreten, zurückgehen, zurückfliessen
reverberation	Nachhall m, Widerhall m
reverberation period (time)	Nachhallzeit f, Widerhallzeit f
ribbon	Band n, Streifen m
rope	Seil n, Tau n, Strick m
sensation	Empfindung f, Sinneswahrnehmung f,
	Gefühl n, Eindruck m; Sensation f
sensation of heat	Wärmeempfindung f
shock wave	Schockwelle f, Druckwelle f, Stosswelle f, Schockfront f, Verdichtungswelle f
slice, to	in Scheiben schneiden, (Luft, Wellen, Wasser) zerschneiden, durchschneiden
sonic bang	
sonic boom (US)	Ueberschallknall m
sound	Schall m, Klang m, Ton m, Laut m; Sonde f; Meerenge f
sound barrier (... ˈbæriə)	Schallmauer f, Schallgrenze f
sound level	Lautstärke f, Schallpegel m

spherical surface	-	Kugelfläche f
spread, to (out) (spred)	-	ausbreiten, ausdehnen
structural engineering	-	Bautechnik f, Ingenieurhochbau m
to-and-fro motion (movement)	-	Hin- und Herbewegung f
transverse wave	-	Transversalwelle f, Querwelle f, transversale Welle
tuning fork	-	Stimmgabel f
wavelet	-	kleine Welle
wave motion	-	Wellenbewegung f

GRAMMAR and NOTES

1) When one end of a rope is fastened to a rigid wall and the free end moved up and down rapidly, each jerk travels along the rope, each portion of the rope communicating the jerk to the next portion.
The compressibility of the kerosene being known, the compressibility of the gas could be calculated.
When a magnet is broken in two, two complete magnets result, two new poles appearing at the fracture.
Hydrogen is the lightest gas known, its normal density being 0.089 87g per litre.

Die Partizipialkonstruktion als adverbiale Bestimmung.

Das verbundene Partizip. Das unverbundene Partizip.

Wenn die Partizipialkonstruktion als adverbiale Bestimmung zur Ergänzung des ganzen Satzes dient, ist sie entweder mit diesem durch das gemeinsame Subjekt verbunden (als sogenanntes "Verbundene Partizip") oder sie hat ein eigenes, vom Hauptsatz verschiedenes Subjekt (als sogenanntes " Unverbundenes Partizip").

Das verbundene Partizip

steht - ähnlich wie im Deutschen - im literarischen Stil als adverbiale Bestimmung meistens an Stelle eines adverbialen Nebensatzes der Umgangssprache.

A. Als Modalbestimmung zur Bezeichnung von Begleit- oder Nebenumständen steht das verbundene Partizip gewöhnlich hinter dem Hauptsatz:

He was left alone, hardly daring to watch or listen.	-	Er wurde alleingelassen und wagte es kaum, zuzusehen oder zuzuhören.

Anmerkung: Mit der Adverbendung -ly versehen, findet sich die -ing-Form gewöhnlich nur in unmittelbarem Kontakt mit dem Prädikat a), während bei der Beziehung auf das Satzganze das rein verbale Partizip steht b):

a) He waved despairingly towards his friend. – Er winkte seinem Freund verzweifelt zu.

He took off his cap and smilingly acknowledged the applause. – Er nahm die Mütze ab und dankte lächelnd für den Beifall.

b) They came in together laughing. – Lachend kamen sie zusammen herein.

They walked out together, talking and laughing. – Redend und lachend gingen sie gemeinsam hinaus.

Whistling and calling, he went this way and that. – Pfeifend und rufend ging er bald in diese, bald in jene Richtung.

B. Als temporale a) oder kausale b) Bestimmung geht das verbundene Partizip dem Hauptsatz gewöhnlich voran. Es kann ihm aber auch folgen oder nach dem Subjekt eingefügt werden:

a) Coming upstairs again, I met Evelyn coming down. – Als ich die Treppe wieder heraufkam, begegnete ich der herunterkommenden Evelyn.

He looked vivid and eager, glancing impatiently up and down the train. – Er sah lebhaft und angeregt aus, während er ungeduldig den Zug entlang blickte.

George, smiling a little sadly, shook his head. – Während er ein wenig traurig lächelte, schüttelte Georg den Kopf.

b) Feeling that she must be alone, she slipped out of the room. – Da sie spürte, dass sie allein sein musste, verliess sie unauffällig das Zimmer.

Her uncle, being extremely lazy, was glad to have her. – Da ihr Onkel ausserordentlich bequem war, war er froh, sie da zu haben.

Konjuktionen wie when, while und (as) though, (as) if können (bzw. müssen) vor das verbundene Partizip treten, um das Verhältnis zum Hauptsatz als temporal, kausal, konzessiv oder konditional zu verdeutlichen:

He had an accident while (he was) coming here. – Beim Herkommen hatte er einen Unfall.

While reading he fell asleep. – Beim Lesen schlief er ein.

He looked in when passing. – Beim Vorbeigehen kam er kurz herein.

He stood back as though expecting them to pass. – Er trat zurück, als ob er erwartete, dass sie vorbeigingen.

Anmerkung: Gelegentlich finden sich derartige Konstruktionen (ähnlich wie im Deutschen) auch ohne Partizip, wenn dieses being wäre:

While at Oxford he had given most of his attention to football. – Als er in Oxford war, hatte sich sein Hauptinteresse auf das Fussballspiel gerichtet.

He retained the consciousness of it while asleep. – Das Wissen darum bewahrte er auch während des Schlafens.

Aber: The remark did not strike him as being at all out of the ordinary. – Die Bemerkung fiel ihm keineswegs als ungewöhnlich auf.

Das unverbundene Partizip

Das im Deutschen nicht mehr gebräuchliche unverbundene Partizip wird vorwiegend in der Literatursprache verwendet. Aehnlich wie das verbundene Partizip steht es als adverbiale Bestimmung:

This part of the country is called East Anglia, Suffolk being the southern part and Norfolk the northern part. - Dieser Teil des Landes heisst East Anglia, und zwar ist Suffolk der südliche und Norfolk der nördliche Teil.

They saw him struggling there, several men striking at him and dragging at his knees. - Sie sahen, wie er dort kämpfte, während mehrere Männer auf ihn einschlugen und an seinen Knien zerrten.

He was sitting at the table, his arms resting upon his open book. - Er sass am Tisch, während die Arme auf dem offenen Buch ruhten.

Anmerkung:der Handlungsträger der unverbundenen Partizipialkonstruktionen kann auch durch ein Personalpronomen bezeichnet sein:

We walked about a little, he showing me first one thing and then another. - Wir gingen ein wenig umher während er mir bald das eine, bald das andere zeigte.

There it (=the fountain) was, I very close to it, kept from it only by some railings...... - Da war sie, und ich (war) ihr ganz nahe, nur durch ein Geländer von ihr getrennt........

Auch in der Umgangssprache finden sich it, this, that oder there in Verbindung mit being:

...That being so, why not simply accept it for the fact it was? - Da dies nun einmal so war, warum sollte man es nicht einfach als Tatsache anerkennen?

There being nothing else to do, we went home. - Da nichts anderes zu tun war, gingen wir nach Hause.

Anmerkung: In konditionaler Funktion wird das Partizip auch in Verbindungen mit permitting gebraucht, vor allem in weather permitting (= if the weather is good enough):

We'll go, weather permitting.	Wenn das Wetter es zulässt, werden wir gehen.
We shall, staff permitting, be able to broadcast our own material.	Wenn es unser Personalbestand zulässt, werden wir unsere eigenen Sachen senden können.

In der Umgansspräche findet sich das "unverbundene Partizip" häufiger, wenn mittels der einleitenden Präposition with der Handlungsträger der Partizipialhandlung (als Objektskasus!) eine engere Verbindung mit dem Hauptsatz zulässt:

The wood is very lovely with the sun shining through the trees.	Der Wald ist sehr hübsch, wenn die Sonne durch die Bäume scheint.
How do you think I can write these birthday cards with you jumping up and down all the time?	Wie glaubst du, dass ich die Geburtstagskarten hier schreiben kann, wenn du die ganze Zeit herumspringst?
He unfolds a plan, and studies it with Dick looking over his shoulder.	Er faltet einen Plan auseinander und sieht ihn sich an, während ihm Dick über die Schulter blickt.

Ein Sonderfall liegt vor bei einigen festen Redewendungen mit dem beziehungslosen Präsenspartizip, in denen kein besonderer Handlungsträger bezeichnet wird, aber auch keine Uebereinstimmung mit dem Satzsubjekt vorliegt.

Hierzu gehören:

Generally speaking... - Allgemein gesprochen...
Strictly
Properly } speaking... - Genau genommen...

Einige solcher Partizipien werden heute (vor Objekten) als Präpositionen a) oder (vor Objektsätzen) als Konjuktionen b) gebraucht, z.B.

a) concerning...
regarding... } - betreffs..., hinsichtlich...
considering... - in Anbetracht..., angesichts...
excepting... - ausgenommen...
including... - einschliesslich...

b) Considering (that)... - In Anbetracht dessen, dass...
Granting (that)... - Zugegeben, dass...
Providing... - Vorausgesetzt, dass...
Supposing... - Angenommen, (dass)...

Everyone, not excepting myself, must share the cost. - Jeder, mich selber nicht ausgenommen, muss sich an den Kosten beteiligen.

Supposing I did go - what would you say? - Angenommen, ich ginge wirklich, was würden Sie sagen?

2. Whatever the nature of the wave, its velocity of propagation is the same so long as the tension is unchanged.
Friction always opposes the motion, whatever its direction.
The second group, known as safety rods, are automatically inserted whenever the process is disturbed, in order to cut short the chain reaction.

Die verallgemeinernden Relativpronomen werden durch Anhängung von -ever (archaisch auch -soever) gebildet:

whatever	–	was auch immer; alles, was
whichever	–	welches auch immer; das, was
whoever	–	wer (wen) auch immer; jeder, der

He will do whatever you tell him to.	–	Er wird alles machen, was Sie ihm auftragen.
Whichever (book) you choose, make sure that it is a good one.	–	Welches (Buch) Sie auch immer wählen, achten Sie darauf, dass es ein gutes ist!
Give it to whoever you like.		Geben Sie es, wem (immer) Sie wollen!

Anmerkung 1: Während what auch in determinativer Funktion (="das, was") gebraucht wird, werden who und which hier durch whoever, whichever ersetzt:

Whoever says that is wrong.	–	Wer (=Derjenige, der) das sagt, hat unrecht!
Take whichever comes first.	–	Nehmen Sie das, was als erstes kommt!

Anmerkung 2: Vom relativen whatever zu scheiden ist das in der Umgangsprache durch ever verstärkte Interrogativpronomen what (=what on earth, what in the world) wie in

What ever do you mean?	–	Was in aller Welt meinen Sie bloss?

3. Word Study

a)	to measure	–	messen
	measure	–	Mass n, Massnahme f, Masseinheit f
	measurable	–	messbar
	measured (by eye)	–	nach Augenmass
	measured value	–	Messwert m
	measuring	–	Messen n, Messung f
	measuring bridge	–	Messbrücke f
	measuring device	–	Messgerät n
	measurement	–	Messung f, Messen n
	measurements	–	Abmessungen f/pl, Dimensionen f/pl

Lasers can be used as measuring instruments for making accurate measurements of very small objects or displacements.

Measuring is the experimental procedure whereby a specific value of a physical quantity is determined as a multiple of a unit or of a reference value.

The measured quantity is the physical quantity to be measured (e.g. length, force, work, temperature, electrical resistance, power factor).

b) to sound	- ertönen, erklingen, erschallen; sondieren; loten, peilen; untersuchen, erkunden
sound	- Schall m, Laut m, Ton m; Loten n, Peilen n; Sonde f; Meerenge f; Lot n; gesund, robust (adj)
sounder	- (telecomm) Hörer m, Lotgerät n, Tiefenmessgerät n, Klopfer m (Telegrafie)
sounding	- (acoust) tönend; Loten n; Sondenuntersuchung f
soundings	- ausgelotete Wassertiefen f/pl, lotbare Wassertiefen f/pl, lotbarer Grund
soundless	- lautlos, klanglos
soundness	- Stichhaltigkeit f; Fehlerlosigkeit f, Lunkerfreiheit f (Guss); Raumbeständigkeit f (Beton)
soundproof	- schalldicht, schallsicher
soundproof, to	- isolieren, schalldicht machen
soundproofed booth	- schalltote Kabine
soundproofing	- Schalldämpfung f, Schalldämmung f, Schallschutz m

Reduction of the sound pressure amplitude by conversion of sound energy to heat is called acoustical absorption.

Sound field is a space through which sound propagates.

Acoustical shadow is a sound-free region behind an impediment.

EXERCISES

1. Use participle constructions in the following sentences:
   As rubber is a good insulator, it is often used in cables. Mercury is used in barometers, because it has a great specific gravity. Radioactivity was discovered; we made great progress in atomic physics. A conic is a curve of the 2nd degree; a straight line cannot intersect it more than twice. The square of any number is positive; the square root of a negative number is imaginary. If we speak strictly, there exist in nature no such bodies. Atomic energy also provides new products that result from transmutations. The situations that require this judgement must be predicted.

2. Translate into German:
   The explanation is to be found in the following fact. The procedures described above are not to be recommended for routine work. The machine was to be controlled through the use of an automatic device. The remaining two points require a great deal of explanation if all the details are to be given. The specimens resemble each other sufficiently to be described as belonging to the same species. The organization of the machine is flexible enough for it to be used for a wide range of operations. When working with electricity, one should always observe the safety rules. Theory enables one in many cases what would otherwise be impossible. Certainly wherever evidence is available, it supports this general conclusion. Whatever the purpose of your stay in our town may be, do not miss the museum. At any rate, the fact remains-whatever the reasons for the fact may be-that such attitudes and rules still

in part prevail.

3. Translate into English:

1) Unter Schallschatten versteht man einen schallfreien Raum hinter einem Hindernis.
2) Die Schallabsorption bedeutet Verminderung der Schalldruckamplitude durch Umwandlung der Schallenergie in Wärme.
3) Von Schall durchsetzter Raum wird Schallfeld genannt.
4) Messen ist der experimentelle Vorgang, durch den ein spezieller Wert einer physikalischen Grösse als Vielfaches einer Einheit oder eines Bezugswertes ermittelt wird.
5) Die Messgrösse ist die zu messende physikalische Grösse (z.B. Länge, Kraft, Arbeit, Temperatur, elektrischer Widerstand, Leistungsfaktor).

Lesson Twelve

OPTICS

Propagation of Light.- Light is a transverse wave motion. It travels through empty space, as well as through such transparent substances as glass, air, and water. Its velocity in free space is 3 x 10^{8} m/sec.

Frequency and Wave Length.- The relation between frequency, velocity, and wave length is the same for light waves as it is for sound waves. The wave length of light is often expressed in ångström units (Å). One ångström unit = 10^{-8} cm.

Rectilinear Propagation of Light.- Under ordinary circumstances, light travels in straight lines and does not appreciably bend around objects.

Sources of Light.- The sun is the chief source of light and heat, but there are many artificial sources. Any body when heated to a sufficient high temperature becomes a source of light. As the temperature of a body is raised, the body emits invisible radiations. When it becomes red-hot, visible radiations begin to be emitted. The higher the temperature, the greater is the amount of both heat and light waves that are emitted, but the percentage of visible radiations becomes larger and larger as the temperature of the source of radiations is increased.

Reflection and Refraction of Light

Laws of Reflection.- When a beam of light, travelling in a homogeneous medium, comes to a second medium, some of the light is reflected. At a polished or silvered surface, nearly all the light is reflected. At the surface of clear glass, only a small part of it is reflected. The greater part of it enters the glass and passes through.

First Law of Reflection:

The incident ray, the reflected ray, and the normal to the surface lie in the same plane.

Second Law of Reflection:

The angle of incidence is equal to the angle of reflection.

Refraction.- Experiments have shown that light travels with the greatest speed in a vacuum and that it travels with different speeds in different mediums. When it passes obliquely from one medium to another in which it has a different velocity, there occurs a change in the direction of propagation of the light. This bending of the ray of light when passing from one medium to another is known as **refraction**.

Refraction through a Prism.- A wedge-shaped portion of a refracting medium bounded by two plane surfaces is called a prism. If the medium of which the prism is composed is optically denser than the surrounding medium, a ray of light incident on one of the faces will be bent toward the normal to the face on entering the prism. On emerging from the opposite face, the ray will be going from a denser to a rarer medium and will be bent away from the normal at that face. The angle through which the ray has been deflected in passing through the prism is called the angle of deviation. When the angle at which the ray enters one face is equal to the angle at which it leaves the opposite face, the angle of deviation has its least value and is known as the angle of minimum deviation.

Critical Angle.- When a ray of light passes from a dense medium such as water to a rarer medium such as air, it is bent away from the normal so that the angle of refraction is greater than the angle of incidence. If the angle of incidence is made larger and larger, the angle of refraction will also become larger and larger and will always be greater than the corresponding angle of incidence. When the angle of incidence is increased sufficiently, the angle of refraction becomes 90 degrees, and the refracted ray travels along the surface of separation between the two mediums. That angle of incidence for which the angle of refraction is 90 degrees is called the critical angle.

Optical Instruments

Lenses.- Lenses are bodies made of transparent material and bounded by faces having a cylindrical or spherical form. Although lenses differ much in form,they may be divided into two classes according to the way in which they act on a parallel beam of light.

A lens or combination of lenses is used in optical instruments to form an image. There are different kinds of lenses:

achromatic lenses
non-spherical lenses
biconcave (double-concave) lenses
biconvex (double-convex) lenses
dielectric (electrostatic) lenses
concavo-convex lenses
convexo-concave lenses
electromagnetic lenses
plane-concave lenses
plane-convex lenses
diverging lenses.

Standards of Illumination.- The intensity of illumination is measured by the amount of light which falls on unit area of a surface. The amount of energy received by unit surface cannot be easily determined in absolute measure. The eye is the most sensitive means of detecting light, but it does not give a quantitative measure of it. By means of the eye it is possible, however, to make an accurate comparison of two intensities of illumination.
To compare sources of illumination, a standard source of illumination is necessary. The choice of these standards is more or less arbitrary. There are a number of such standards in use.

The Lumen.- The unit used to denote quantity or amount of light is the lumen (lm). A lumen is the amount of light falling on a surface that has an area of 1 ft^2 when every point of the surface is 1 ft from a point source of light of one candle.

Candle Power.- The candle power of a lamp is a specification of its illuminating power in terms of some standard candle. It is a unit of luminous intensity equal to 1/60 of the luminous intensity of one square centimetre of a blackbody at the temperature of solidification of platinum. It is also called candela (cd).

Lux (lx).- It is a unit of illumination, equal to one lumen per square metre or to the illumination of a surface uniformly one metre distant from a point source of one candle.

Nit (nt) is also used as a unit of luminance.

Dioptre is a unit of measure of the refractive power of a lens, equal to the power of a lens with a focal distance of one metre.

QUESTIONS

1) What is meant by propagation of light?
2) What is the velocity of light?
3) How does light travel under ordinary circumstances?
4) What is the chief source of light and heat?
5) What are the sources of artificial light?
6) By means of what may light be reflected? refracted?
7) What do we call the angle of deviation?
8) What is known as the angle of minimum deviation?
9) What is meant by angle of incidence? angle of reflection?
10) Is a beam of light refracted towards or from the perpendicular when passing from air into glass?
11) What is an optical delusion?

IMPORTANT TERMS

angle of deflection ('æŋgl···)	-	Ablenkungswinkel m, Ausschlagwinkel m
angle of deviation	-	Ablenk(ungs)winkel m, Abweichungswinkel m
angle of divergence	-	Austrittswinkel m eines divergenten Strahlenbündels; Erweiterungswinkel m, Divergenzwinkel m
angle of emergence	-	Austrittswinkel m, Ausfallswinkel m
angle of impact	-	Auftreffwinkel m

angle of incidence	–	Einfallwinkel m (von Wellen); Anstellwinkel m (Raketentechnik)
angle of inclination	–	Neigungswinkel m
angle of intersection	–	Durchdringungswinkel m
angle of reflection	–	Reflexionswinkel m, Ausfallwinkel m
angle of refraction	–	Brechungswinkel m
angle of scattering	–	Streuwinkel m
angle of view	–	Blickwinkel m
arbitrary	–	beliebig, willkürlich
beam of light	–	Lichtstrahl m, Lichtbüschel m
beam of rays	–	Strahlenbündel n
bend, to	–	biegen, durchbiegen
candela	–	Candela f, Neue Kerze
candle	–	Kerze f, Candle f , Internationale Kerze
candle power	–	Kerzenstärke f
delusion	–	Täuschung f, Selbsttäuschung f, Irrtum m, Wahn m
dense	–	dicht
dioptre (dai'ɔptə)	–	Dioptrie f; Diopter n, Visierinstrument n
illumination	–	Beleuchtung f, Belichtung f, Ausleuchtung f; Beleuchtungsstärke f
invisible	–	unsichtbar
lens	–	Linse f; Objektiv n; Lupe f
luminance	–	Leuchtdichte f, spezifische Lichtausstrahlung; Helle f (telev)
rare	–	selten, rar; verdünnt
reflection	–	Reflexion f, Rückstrahlung f, Spiegelung f
refraction	–	Brechung f, Refraktion f, Strahlenbrechung f
wedge-shaped	–	kegelförmig, keilförmig; kommaförmig (Span)

GRAMMAR and NOTES

1) Any body when heated to a sufficient high temperature becomes a source of light.

Als adverbiale Bestimmung kann das Perfektpartizip - ähnlich wie das Präsenspartizip - zur Ergänzung des ganzen Satzes als verbundene oder unverbundene Partizipialkonstruktion auftreten.

Das verbundene Perfektpartizip wird verschieden konstruiert, je nachdem, ob es mit aktivischer oder passivischer Bedeutung verwendet wird.

A) Bei aktivischer Bedeutung wird es in Verbindung mit having konstruiert:

The other lunchers, having begun simultaneously, were ending simultaneously. - Da die anderen Frühstückenden gleichzeitig begonnen hatten, hörten sie jetzt gleichzeitig auf.

B) Bei passivischer Bedeutung steht gewöhnlich nur das Perfektpartizip:

Seen from here the town was the town he loved, all beauty and peace. - Von hier aus gesehen, war die Stadt so recht die Stadt, die er liebte; ganz Schönheit und Friede.

Diese Konstruktion findet sich auch nach Konjunktionen wie if und as if/as though (=„als ob"):

If pressed I would perhaps have told them. - Wenn ich dazu gedrängt worden wäre, hätte ich es ihnen vielleicht erzählt.

They both stood as if turned to stone. - Alle beide standen sie wie versteinert (....wie zu Stein geworden).

Das unverbundene Perfektpartizip ist ähnlich wie das Präsenspartizip vorwiegend auf die Literatursprache beschränkt:

All things considered, we may say...	- Wenn man alles in Betracht zieht (oder: Nachdem alles in Betracht gezogen worden ist), kann man sagen...

Anmerkung: Gelegentlich findet sich auch hier beim Perfektpartizip einleitendes with:

It would be five hundred pounds on the top of his seventeen hundred, with every shilling of it given another value.	- Es würden (dann) 500 Pfund zu seinen 1700 hinzukommen, wobei jeder Schilling einen anderen Wert bekäme.

2) The higher the temperature, the greater is the amount of both heat and light waves that are emitted, but the percentage of visible radiations becomes larger and larger as the temperature of the source of radiations is increased.

Zwei Komparative werden durch the...the "je...desto, je...je" in Beziehung zueinander gesetzt:

The sooner, the better.	- Je eher, desto besser.

3) Word Study

to reflect	- zurückstrahlen, zurückwerfen, reflektieren
reflectance	- Reflexionskoeffizient m; (opt) Reflexionsvermögen n
reflected	- gespiegelt, reflektiert
reflected ray	- reflektierter Strahl
reflecting	- zurückstrahlend, zurückwerfend
reflecting power	- Reflexionsvermögen n, Rückstrahlvermögen n
reflection	- Reflexion f, Spiegelung f
reflection effect	- Reflexionseffekt m
reflective	- reflektierend, spiegelnd
reflective optics	- Projektoroptik f

reflective power	- Reflexionsvermögen n
reflectivity	- Reflexionsvermögen n, Reflexionsfähigkeit f
reflector	- Reflektor m, Rückstrahler m
reflectoscope	- Reflektoskop n; Episkop n
reflex	- Reflex m; Spiegelbild n; reflektiert, gespiegelt; reflektorisch
reflexible	- reflektierbar
reflexion	- Reflexion f, Spiegelung f, Rückstrahlung f
reflexotherapy	- (med) Reflextherapie f

The ratio of the reflected to the incident sound intensity is called reflection factor.

Reflectivity is a measure of the fraction of radiation reflected by a given surface; defined as the ratio of the radiant energy reflected to the total that is incident upon that surface.
The system of mirrors and lenses used in projection television is called reflective optics.

EXERCISES

1) Translate into German:

Following the instructions you cannot make a mistake. Having made the necessary arrangements we proceeded to carry out the project. The results being doubtful, the procedure was not recommended.
This defect having been removed, the machine operated satisfactorily. Reference to the history of these changes is made at various points in the book, the exceptions being dealt with especially in Chapter Five. The electricity is carried exclusively by electrons, the atomic nuclei remaining stationary. There being little evidence, the hypothesis could not be either confirmed or refuted. Having established a basis for this theory, the next step is to analyse the structure and properties

of the components. Having done this it is desirable, wherever possible, to discover the causes of the observed errors. These obstacles having been removed, the scheme was carried out without further delay. Having obtained the relation we may study the manner in which the value of the function varies with that of the independent variable. The sooner the work can be done, the better. The longer he explained the point, the more complicated he made it.

2) Translate into English:

1) Die in diesem Beitrag behandelte Theorie befasst sich mit Problemen, die bei der Ermittlung des Verhaltens von linearen Systemen entstehen, wenn sie durch einen Impuls erregt werden.

2) Ohm ist die nach dem deutschen Physiker Ohm (1787 - 1854) benannte praktisch-elektrotechnische Einheit für den elektrischen Widerstand.

3) Da die Spulen ein wesentlicher Bestandteil des Transformators sind, wurden ebenfalls die ersten Schritte zum Mechanisieren des Wickelns von Transformatorenspulen unternommen.

4) Darauf aufbauend, sollen im vorliegenden Abschnitt der Bau und die den Techniker interessierenden Eigenschaften der Halbleitergleichrichter geschildert werden.

5) Je höher diese Frequenz ist, desto grösser ist der induktive Widerstand und desto kleiner ist der sich einstellende Strom.

LIGHT ENERGY

Light energy is captured from nature almost solely by plant growth. To store it, except in minute amounts by phosphorescent chemicals, is impossible. Since it cannot be stored, it cannot be transported in storage. It transmits itself, but its measurement is a thing of considerable difficulty, and recording is even more difficult. To control its formation from other forms of energy is usually relatively easy, but for it to control any other form of energy is very difficult. Its transformation into other forms of energy is greatly limited by lack of suitable means.

In this discussion of light we must not forget that light, as ordinarily accepted, is distinct from radiant heat, and hence the energy as light is really quite small. If heat be absorbed out of sunlight, the remainder is a very small amount of energy. This energy cannot be transformed into usable mechanical energy. It may be transformed into heat, but the resulting heat is very small. It is transformed into chemical energy by many natural processes of growing tissues, especially in plants. It never makes a sound, it has no magnetic effect which can be detected by ordinary magnetic detecting devices, and it is transformed from one wave length of light to another with extreme difficulty.

From this one sees that while light energy is of such great importance to the human race, the things which it can be made to do are greatly limited. It can make us see, it can be recorded by a camera and it can be transformed into electrical energy by the photoelectric cell.

How brief a recital this makes compared with the recital of electric energy, which can be transformed quickly into other forms of energy, which by simple means controls almost any form of energy, and yet which itself is by nature so infrequently applied to the human system. It is very fortunate for us that one of our first light detecting instruments - the photoelectric cell - controls so universally applicable an energy as electricity. The human race has had for many years mechanical prime movers, mechanical legs and arms, and it has had electrical heaters, chemical heaters and so on, but the human race has been dependent upon the human eye for its detection and record of light. If the photo-electric cell can be made by a simple process to take the place of the human eye in certain places, it can be of great service to mankind.

QUESTIONS

1) Is it possible to store light energy? 2) Why is its measurement a thing of considerable difficulty? 3) Is it easy to control its formation from other forms of energy? 4) How is its transformation into other forms of energy greatly limited? 5) Is light energy of great importance? 6) Can it be recorded by a camera? 7) Into what can it be transformed by the photoelectric cell? 8) What does the photo-electric cell control? 9) Upon what has the human eye been dependent? 10) How can the photo-electric cell be of great service to mankind?

IMPORTANT TERMS

angle of incidence ('æŋgl əv 'insidəns)	Einfallwinkel m, Anstellwinkel m (Raketentechnik)
brief (bri:f)	kurz, von kurzer Dauer
capture, to ('kæptʃə)	ergreifen, einnehmen, fangen
check, to	kontrollieren; überprüfen, nachrechnen
chemicals ('kemikəlz)	Chemikalien f/pl
control, to	steuern, lenken; regeln, regulieren; überwachen; schalten
detecting instrument	Indikator m; Suchgerät n, Spürgerät n; Messfühler m

diffraction	Beugung f, Diffraktion f
electric heater	Elektroofen m, elektrischer Heizkörper
focal length	Brennweite f, Fokallänge f; Brennpunktabstand m
growth	Wachstum n; Zunahme f, Anwachsen n; Anbau m
human race	Menschengeschlecht n
lack (læk)	Mangel m, Fehlen n, Nichtvorhandensein n
mechanical arm	mechanischer Arm, Manipulator m
minute (very small) (mai'nju:t)	klein, sehr gering
phosphorescent (,fəsfə'resnt)	phosphoreszierend, leuchtend
photoelectric cell	fotoelektrische (lichtelektrische) Zelle, Fotozelle f
plant (pla:nt)	Anlage f, Betriebsanlage f; (Am.) Betrieb m, Fabrik f, Werk n; Pflanze f
prime mover	Kraftmaschine f, Antriebsmotor m
radiant heat	Strahlungswärme f, Wärmestrahlung f
recital (ri'saitl)	Darstellung f des Sachverhalts od. Zwecks; Feststellung f, Bestimmung f; Schilderung f; Bericht m; Vortrag m
recording	Aufzeichnung f, Eintragung f; Aufnahme f; Speicherung f
reflection	Spiegelung f, Reflexion f
refraction	Brechung f, Refraktion f
remainder	Rest m, Rückstand m
tissue ('tiʃu:, 'tisju:)	Gewebe n, Zellgewebe n; Stoff m (Papierherstellung)

GRAMMAR AND NOTES

1. If heat be absorbed out of sunlight, the remainder is a very small amount of energy.

Im literarischen Stil (vor allem im amerikanischen Englisch) wird in Nebensätzen der Konjunktiv des Präsens verwendet, um die Aussage nicht als Tatsache, sondern als zweifelhaft oder als blosse Annahme oder Vermutung hinzustellen:

a) in Bedingungssätzen:

If this be true, she will soon tell you.

Wenn dies stimmen sollte, wird sie es dir bald mitteilen.

I shall not stay at home even if the weather be bad.

Ich werde nicht zu Hause bleiben, selbst wenn das Wetter schlecht ist.

b) nach Verben, die einen Befehl oder eine Aufforderung ausdrücken:

They proposed that a delegate of Great Britain be invited.

Sie schlugen vor, dass ein Vertreter Gross Britanniens eingeladen würde.

c) nach unpersönlichen Ausdrücken, die etwas als notwendig oder wünschenswert hinstellen:

It is advisable (or: desirable) that she go.

Es ist ratsam (oder: wünschenswert), dass sie geht.

Anmerkung: In der Umgangssprache wird in diesen Fällen entweder eine Umschreibung mit should angewandt oder der Indikativ oder der Infinitiv gesetzt:

It is advisable that she should go (or: that she goes; or: for her to go).

Im Präteritum finden sich besondere Konjunktivformen nur für den Singular von to be. Die Vergangenheitsbedeutung ist, ähnlich wie im Deutschen, nicht mehr vorhanden:

If he were here ... Falls er hier wäre ...

In der Umgangssprache ebenso wie in der Literatur werden diese Formen in Nebensätzen verwendet, um eine Aussage als nicht wirklich (irreal) hinzustellen:

a) in Bedingungssätzen:
If I were you, I wouldn't do it.
Wenn ich Sie wäre, würde ich es nicht tun!

Anmerkung: In der Umgangssprache findet sich hier auch was an Stelle von were: If I was you, I would not do such things.

Gleichfalls in Bedingungssätzen findet sich were in Verbindung mit to, um einen sehr geringen Grad der Wahrscheinlichkeit auszudrücken:

If he were to do it, I would be very glad.
Falls er es (doch) tun sollte (= täte), würde ich mich sehr freuen.

b) nach as if oder as though (= "als ob"):
It isn't as if she were poor.
Es ist nicht so, als ob sie arm wäre.

c) nach to wish:
I wish it were true.
Ich wünschte, es wäre wahr!

Entsprechend den im Deutschen üblichen Konjunktivumschreibungen mit "möge, sollte, wollte, würde" werden may, shall und die Konditionalformen might, could, should, would weitgehend als Funktionswörter zum Ausdruck eines konjunktivischen Verhältnisses verwendet.

EXERCISES

1. Change into the construction "for" ... to":

It is necessary that atomic energy should be used for industrial purposes. There is no reason why the conversion of mechanical into radiated energy should be continuous. It is essential that an engineer should have a good knowledge of higher mathematics. It is natural that scientists should try to unite the corpuscular and electromagnetic theories of matter. It is important that you should know English well.

2. Translate into German:

There is no reason for us to believe that we already know all the particles of which the atom consists. In January 1948, M. Joliot - Curie discovered a particle that is negatively charged, but whose mass (but the mass of which) is three times as great as that of the electron. According to Bohr, it is possible for an electron to move round the nucleus along certain "permissible" orbits, without radiating electromagnetic energy.

Beta - disintegration (the emission of electrons or positrons by the nuclei of certain radio - active atoms), which, it would seem, represents the changing process between the neutrons and the protons of the nucleus, could not be satisfactorily explained in this way. The energies observed in beta - disintegration exceed theoretical calculations many times.

In 1935, however, a Japanese physicist, Yukawa, published an hypothesis, in which he forecast the existence of particles of "medium" mass, i. e. of mass greater than that of the electron but smaller than that of the proton. Such particles were in fact later, in 1937, experimentally ascertained in cosmic radiation. These particles, called "mesotrons" have a mass about 200 times greater than that of the electron. Mesotrons are unstable, their life equals two millionths of a second, if we reckon the time in the system of the mesotron itself and - as follows from the theory of relativity - correspondingly more if we express that time in the system of the measuring instruments, in relation to which the mesotron is moving with an extremely great velocity.

3. Translate into English:

1) Der Mensch ist in seiner gesamten Tätigkeit vom Licht abhängig. 2) Die Lichttechnik stellt eine durchaus selbständige Wissenschaft dar, die sich zum Teil auf die Ergebnisse anderer Wissenschaften gründet. 3) Das Licht stellt bekanntlich eine elektromagnetische Wellenbewegung dar, genauso wie die Rundfunkwellen, Röntgenstrahlen usw. 4) Wenn er diese Erfindung nicht gemacht hätte, wäre diese Maschine wohl nicht möglich gewesen. 5) Verbinden wir die Klemmen einer Spannungsquelle mit einem Widerstand, so haben wir die einfachste Form eines Stromkreises vor uns. 6) Fehlt dem Studenten hierzu die Möglichkeit, sollte er die Messungen doch wenigstens gründlich durchdenken. 7) Ist das Wasser nicht chemisch rein, so überwiegt die elektrolytische Leitung. 8) Man unterscheidet die Feinabstimmung von der Grobabstimmung. 9) Es ist bekannt, dass Aluminium von Seeluft angegriffen wird. 10) Elektromotoren sind sorgsam vor Schmutz und Staub zu bewahren. 11) Die Leistung des Motors wäre in beiden Fällen gleich gross. 12) Meinen Sie nicht, wir hätten den Apparat besser machen können? 13) Ich hätte nicht geglaubt, dass dies möglich sei. 14) Es sei vorausgesetzt, dass der Ladewiderstand viel grösser ist als der Entladewiderstand.

Lesson Fourteen

MAGNETISM and ELECTRICITY

Magnets.- A peculiar mineral (Fe_3O_4) called lodestone was found in early times in the neighbourhood of Magnesia in Asia Minor. This mineral has the power of attracting small particles of the same mineral and of setting itself in one particular direction when suspended. When a piece of this lodestone is dipped into iron filings, they adhere to it. It is found that there are two places on each piece of this mineral at which the iron filings adhere in greatest quantities. If such a piece of lodestone is suspended by means of a silk thread, it is found that the line joining the places at which the iron filings adhere in greatest quantities points north and south.

Magnetic Poles.- On dipping a magnetized needle into iron filings it is seen that the iron filings adhere most strongly at the ends of the needle. These places at which the tendency of the iron filings to cling to the needle is greatest are called poles. If that end of a suspended needle may be disturbed, it will come to rest with the marked end pointing north. For convenience, it is desirable to call the end of the magnetic needle that points north the north-seeking pole, or N-pole. The other end is called the south-seeking pole, or the S-pole.

Law of Force between Magnetic Poles.- Experiments show the following:

1. Like poles repel each other, but unlike poles attract each other. Thus, two N-poles repel each other, and two S-poles repel each other, but an N-pole and an S-pole attract each other.
2. The force with which the poles of two magnets attract or repel each other, in a vacuum, is equal to the product of the pole strength divided by the square of the distance between the poles.

Magnetic Field.- The space outside the magnet in which its influence can be detected is called the magnetic field.

In the case of powerful magnets this space extends far from the magnet, but in the case of feeble magnets the magnetic field is so weak that it may be considered as confined to a small region near the magnet.

At every point near a magnet or a system of magnets, a free magnetic pole would experience a force tending to drive it in a definite direction. The direction in which a free N-pole would move is called the direction of the magnetic field and the magnitude of the force on unit pole is known as the intensity of the magnetic field. The intensity of the magnetic field, or the magnetic intensity, is thus defined to be the mechanical force measured in dynes (dyn) that is exerted on unit pole at a point in free space. The unit of magnetic intensity is called the oersted (Oe). If the magnetic field is such that there is a force of 1 dyne on unit pole, the magnetic field or the magnetic intensity at that point is 1 oersted.

Unit Pole.- A unit pole is a pole of such strength that it will repel a similar pole of equal strength with a force of 1 dyne when placed 1 cm away from it in a vacuum. An isolated pole is not a physical possibility, since every magnet must have an equal south pole for every north pole. It is possible to realize approximately the conditions assumed in this definition by supposing that the magnets are very long, so that the influence of the other pole is small. The number of unit poles on the end of a magnet is measured by the number of dynes of force that it will exert on a unit pole 1 cm from it in a vacuum. The force in air differs little from the force in a vacuum. Hence, the distinction between air and vacuum may be neglected.

Magnetic Lines of Force.- Imaginary lines whose direction and concentration form a convenient description of a magnetic field are called lines of magnetic force. Such a line of magnetic force is the path along which a perfectly free N-pole would travel when left alone in the magnetic field. Since such a free N-pole cannot be obtained in practice, a small compass needle is used to determine the direction of the magnetic field at a point. When the compass needle comes to rest, its axis points in the direction of the magnetic field at that point. In order to represent the strength of the magnetic field, there is a well-established convention concerning the number of lines of force to be drawn per unit area. The agreement is that the number of lines of force per square centimeter will be just equal to the number of dynes with which the field would act on a unit pole. For example, a magnetic field equal to 10 oersteds is represented by drawing 10 lines of force per square centimetre.

Molecular Theory of Magnetism.- It is assumed that every substance which is capable of being magnetized consists of a very large number of molecular magnets, probably no larger than the molecules out of which the substances are made. When the substance is unmagnetized, these molecular magnets are not arranged in any particular direction, but are oriented indiscriminately. When the substance is magnetized, a larger number of them are made to point along the axis of the magnet than point in another direction. In the interior of the magnet, the little north poles lie so close to the little south poles that each destroys the influence of the other. At one end of the bar free north poles, and at the other end are free south poles. The sum of all these little north poles makes the N-pole of the magnet,and the sum of all the little south poles makes the S-pole of the magnet.

Magnetic Induction.- When a bar magnet is placed near a piece of unmagnetized iron, the elementary magnets in the iron tend to arrange themselves so that all the N-poles point in one direction and all the S-poles in the opposite direction. The piece of iron thus becomes a magnet so long as it is in the presence of the permanent bar magnet. South-seeking poles are produced near the north-seeking pole of the bar magnet and north-seeking poles at the other end of the piece of soft iron. This process of magnetization is known as magnetization by induction.

THE ELECTRON THEORY

According to modern theory all matter is composed of atoms, tiny particles that are the building blocks of the universe. There are many kinds of atoms, one or more for each chemical element. Each atom consists of a nucleus, a small, tightly packed positively charged mass, and a number of larger, lighter, negatively charged particles called electrons, which revolve about the nucleus at tremendous speed. The centripetal force necessary to draw these electrons into their circular or elliptical paths is supplied by the electrical attraction between them and the nucleus. The nucleus consists of a number of protons, each with a single positive charge, and (except for hydrogen) one or more neutrons which have no charge. Thus the positive charge on the nucleus depends upon the number of protons that it contains. This number is called the atomic number of the atom. A neutral atom contains equal numbers of electrons and protons. Each electron carries a single negative charge of the same magnitude as the positive charge of a proton, so that the attraction between the nucleus of an atom and one of the electrons will depend on the number of protons in the nucleus.

Since the mass of a proton or a neutron is about 1840 times that of an electron, the mass of the atom is concentrated in the nucleus. The chemical properties of the atom are determined by the number of protons in the nucleus.

A solid piece of material consists of unconceivably large number of atoms clinging together. Though these atoms may be vibrating about their normal positions as a result of thermal agitation, their arrangement is not permanently altered by this motion. Also present in solids are numbers of free electrons, so called because they are temporarily detached from atoms. The number and freedom of motion of these electrons determine the properties of the material as a conductor of electricity. A good conductor is a material containing many free electrons whose motion is not greatly impeded by the atoms of which the material is composed. As a result of the repulsive forces between them, free electrons spread throughout the material, and any concentration of them in any one region of the material will tend to be relieved by a motion of the electrons in all directions away from that region until an equilibrium distribution is again reached.

In the best conductors, the outer electrons of the atoms can easily be removed, so that a free electron with an atom often causes an outer electron to leave the atom. When this happens, the ejected electron becomes a free electron, moving on, while its place in the atom is taken by another free electron that encounters the atom. An insulator or poor conductor is a substance that contains very few free electrons and whose atoms have no loosely held orbital electrons.

Electrification.- If a piece of sealing wax, hard rubber, or one of many other substances is brought into intimate contact with wool or cat's fur, it acquires the ability.to attract light objects such as bits of cork or paper. The process of producing this condition in an object is called electrification, and the object itself is said to be electrified or charged with electricity.

ELECTROSTATICS

There are two states of electrification, or, as is usually said, two kinds of electricity: that which appears on an ebonite rod when rubbed with cat's fur and that which appears on a glass rod rubbed with silk. These charges differ in one important respect. Charges which are alike repel each other, and charges which are unlike attract each other. That kind of electricity which appears on a glass rod that has been rubbed with silk is called positive electricity and the kind which appears on an ebonite rod rubbed with cat's fur is called negative electricity.

Electric Field of Force.- The region surrounding one or more charged bodies is known as the electrostatic field. It is frequently represented by drawing lines which represent the direction in which the force on a positive charge acts at different points in the neighbourhood of the bodies. Such lines are called lines of force. They show the direction in which a positive charge would move if it were placed in the field of force.

The intensity of an electric field is determined by the force that unit positive charge experiences when placed in it.

Positive and Negative Charges.-

The only way to charge a body negatively is to add electrons to it, and the only way to charge it positively is to take electrons away from it, leaving an excess of positive electricity. When the rubber rod was charged negatively by rubbing with cat's fur, some electrons passed from the cat's fur to the rubber rod, leaving the cat's fur charged positively and the rubber charged negatively. On the other hand, when the glass rod was charged positively by rubbing with silk, some electrons passed from the glass to the silk, leaving the glass rod charged positively and the silk charged negatively.

In the normal condition, the amount of positive electricity in the atom is just equal to the amount of negative electricity on its electrons. One or more of these electrons may be detached from the atom, leaving it with an excess of one or more positive charges of electricity. In such a case, the residue that is left after detaching these electrons is what is called a positively charged ion. On the other hand, an atom may gain one or more electrons in excess of its quota. It has on it then one or more negative charges and becomes a negatively charged ion.

Conductors and Insulators.-

In some cases the forces holding the electrons to the atoms are not very large. They may be detached temporarily and wander about in the vacant space between the atoms. Thus in copper and silver some of the electrons become detached from the atoms and wander about for longer or shorter times in the interstices between the atoms. Under the action of an electric force, these electrons migrate through the metal. Such substances in which there are free electrons which can be made to migrate through the substance under the action of an impressed electric force are called conductors. Metals belong to this class of bodies.

If the electrons are rigidly bound to the atom so that they do not become free except under the action of very large forces, no free electrons will be found in the vacant spaces between the atoms. If an electric force is applied to such a substance, it cannot cause the electrons to migrate through the substance, and there is no flow of electrons from one part of the substance to the other. If an excess number of electrons be placed on one part of such a substance, they will remain there without wandering to other parts of the body. The most that an impressed electric force can do in such a case is to cause a limited displacement of the electrons within the atom without causing the electrons to migrate from atom to atom. Such substances are called nonconductors or insulators. To this class of substances belong mica, porcelain, quartz, glass, wood, ebonite, etc.

THE ELECTRIC CURRENT

In a metal there are a large number of electrons which are more or less free and which are capable of migrating through the metal under the action of an impressed electric force. When such an electric force is applied to the metal and a stream of these electrons migrates from one part of the metal to another, there is said to be an electric current in the conductor. This flow of electricity through a conductor is analogous to the flow of water through a pipe. The migration of electrons through wires occurs with great ease, and the very smallest electric pressures are sufficient to set the electrons in motion.

Laws of Resistance.- The laws that apply to the resistance of a conductor at constant temperature are as follows:

1. The resistance of a conductor is proportional to its length.
2. The resistance of a conductor is inversely proportional to its cross-sectional area.
3. The resistance of a given conductor depends on the material out of which it is made.

ELECTRIC CIRCUITS

In order to apply and to control the heating, chemical, or magnetic effects, the engineer must control the current. One of the most widely used of the laws related to electric current is Ohm's law. From this law and its extensions, vital circuit relationships can be determined. From the point of view of practical electricity, series and parallel circuits are of primary importance. The electrician, the electrical engineer, the physicist, and many others are concerned with the relationships involved in the series and parallel connection of various pieces of equipment. *Ohm's law* is the relationship between current, electromotive force and resistance which states that the current in amperes in a direct-current circuit is equal to the electromotive force in volts divided by the resistance in ohms.

EMF and Internal Resistance.- A battery or other source supplies a potential difference for the circuit to which it is connected. Every such source has within it some resistance called *internal resistance*. When there is no current in the battery, the potential difference E between its terminals is a maximum that is called its *emf*, or no-load voltage. The abbreviation *emf* represents *electromotive force*, but the use of "force" in this term is so misleading that it is desirable to use the abbreviation emf without any thought of the original term.

When a current is being maintained by a battery, the voltage across its terminals is less than the emf by the amount of the drop in potential across the internal resistance.

$$V = E - Ir$$

where V is the terminal potential difference and r is the internal resistance of the battery. For any battery or other source of constant emf the terminal voltage decreases as the current increases. A battery of low internal resistance can, however, supply a large current without much decrease in its terminal voltage.

QUESTIONS

1) What power has the peculiar mineral (Fe_3O_4) called lodestone?
2) What do we understand by "artificial magnet"?
3) To whom does the theory of electro-magnetism owe much?
4) What is meant by "magnetic field"?
5) What is understood by "magnetic induction"?

6) What is all matter composed of?
7) By what is determined the intensity of an electric field?
8) What are the main effects of an electric current?
9) What does law of resistance say?
10) What does the abbreviation emf represent?
11) What is the best thermal insulator?

IMPORTANT TERMS

brush, to	-	bürsten, bestreichen
cling, to	-	anhaften, sich anklammern
conductor	-	Leiter m, Leitungsdraht m
encounter, to	-	antreffen, begegnen
extension	-	Ausdehnung f, Dehnung f, Ausbreitung f
indiscriminate	-	unterschiedslos
insulator	-	Isolator m, Nichtleiter m
involve, to	-	einbeziehen, einschliessen, enthalten, mit sich bringen
ion (ˈaiən)	-	Ion n
iron filings	-	Eisenfeilspäne m/pl
isolator	-	Trennschalter m, Trenner m ; Richtleiter m, Richtungsisolator m
lodestone	-	Magneteisenerz n, Magneteisenstein m, Gangerz n
mica (ˈmaikə)	-	Glimmer m
physician (fiˈziʃən)	-	Arzt m
physicist (ˈfizisist)	-	Physiker m
pith ball	-	(phys) Holundermarkkügelchen n (zum Nachweis der elektrostatischen Anziehung)
rub, to	-	(ab)reiben, (ab)wischen; schleifen, polieren
sealing wax	-	Siegellack m; Abdichtwachs n
silk thread	-	Seidenfaden m
unconceivable	-	unabsehbar

GRAMMAR and NOTES

1. In order to represent the strength of the magnetic field, there is a well-established convention concerning the number of lines of force to be drawn per unit area.

The current to be measured enters the coil through the wire.

Die Verbindung to be to + Infinitiv wird als modales Hilfsverb in der Bedeutung "sollen" verwendet. Hat der Infinitiv passivischen Sinn, so hat er in der Regel auch die passivische Form. Gelegentlich werden der passivische und der aktivische Infinitiv mit einem Unterschied in der Bedeutung nebeneinander verwendet wie z B.:

There was nothing to be seen.	Es war nichts zu sehen. Man konnte nichts sehen.
There was nothing to see.	Es gab nichts (Besonderes) zu sehen.
That is the book to be chosen.	Das ist das Buch, auf das die Wahl fallen wird.
That is the book to choose.	Das ist das Buch, auf das die Wahl fallen sollte.

Der aktivische Infinitiv erklärt sich hier meist aus seinem älteren substantivischen Gebrauch als Objekt nach präpositionalem to. Erst später wurden, der verbalen Auffassung entsprechend, daneben passivische Formen gebildet.

Aehnlich steht der passivische Infinitiv an Stelle einer deutschen Mischform aus Infinitiv und Präsenspartizip:

They have come to an agreement on the goals to be reached and the methods to be used.	Sie haben sich über die zu erreichenden Ziele und die anzuwendenden Methoden geeinigt.

2. In the interior of the magnet, the little north poles lie so close to the little south poles that each destroys the influence of the other.

The neutrons escaping from the walls of a reactor include some with thermal velocities and others with energies up to 2 MeV or more.

Other "ander" wird gleichfalls attributiv und substantivisch verwendet:

the other day;	neulich;
some day or other	irgendwann einmal
some one or other	irgend jemand
One or other of us will be there.	Irgendeiner von uns wird dasein.
one after the other	nacheinander
one from the other	voneinander
each other (= one another)	einander, sich
the other two;	die anderen beiden;
the two others	die beiden anderen
If these plugs are no use, can you send me some others?	Wenn diese Stecker nichts taugen, können Sie mir dann andere schicken?
Have you any others?	Haben Sie noch andere?
Give me some other ones.	Geben Sie mir andere.
Give me the other one, not this one.	Geben Sie mir das andere, nicht dieses.
It was none other than Smith.	Es war niemand anders als Smith.
I could do no other than I did.	Ich konnte nichts anderes tun, als ich getan habe.

Anmerkung: Gelegentlich wird bei paarweise vorkommenden oder aus zwei gleichen Teilen zusammengesetzten Gegenständen wie trousers, shoes, scissors die Form the other ones gebraucht, um ein einzelnes anderes Paar zu bezeichnen:

If those shoes are uncomfortable, put your other ones (or: others) on.	Wenn die Schuhe (da) unbequem sind, zieh die anderen an!

Das gewöhnliche the others hat hier oft die Bedeutung "alle anderen".

3. Word Study

a) insulance (insulation resistance) - Isolationswiderstand m

insulant	- Isolierstoff m, Isoliermaterial n; Dämmstoff m (Schall, Wärme); Sperrstoff m (Feuchtigkeit)
insulate, to	- isolieren; dämmen (Schall, Wärme); sperren (Feuchtigkeit)
insulated	- isoliert
insulated conductor	- isolierter Leiter
insulated tongs	- Isolierzange f
insulating	- isolierend, Isolier...
insulating compound	- Isoliermittel n, Isoliermasse f, Isolationsmasse f, Vergussmasse f
insulation	- Isolierung f, Isolation f; Dämmung f (Schall, Wärme); Sperrung f (Feuchtigkeit)
insulation against ground	- Isolation f gegen Erde
insulation compound	- Isolationsmasse f, Isoliermasse f
insulation resistance	- Isolationswiderstand m
insulation tape	- Isolierband n
insulativity	- Isolierfähigkeit f; spezifischer Widerstand; Würfelwiderstand m
insulator	- Isolator m; Isolierstoff m; Nichtleiter m; Isolierkörper m; Dämmstoff m
insulator-type transformer	- Topfwandler m
b) isolate, to	- (gen) isolieren, absondern, trennen; rein darstellen (chem); kapseln (Lärm); einen Stromkreis unterbrechen, entkoppeln; extrahieren (comput)
isolated	- vereinzelt, einzeln dastehend
isolated chimney	- freistehender Schornstein
isolating	- Trenn...
isolating switch	- Trenn(schutz)schalter m

isolation	(el) Trennung f, Abschaltung f; (chem) Reindarstellung f, Absonderung f, Kapselung f (Lärmerzeuger); (gen) Isolation f, Isolierung f
isolation of beets	Vereinzeln (Verziehen) n der Rüben
isolator	Trennschalter m, Trenner m; Richtleiter m, Richtungsisolator m; (telecomm) Pufferstufe f (a buffer stage)
isolator stage	Trennstufe f (Radio)

The term insulation resistance covers every electrical resistance value of an insulating material as measured between two electrodes. It is necessary to distinguish between the insulation resistance in the interior of the material and on the surface of the material.

Insulating films according to DIN 40 634 are plastic films used for electrical insulations. They are also called electrical insulating films. This term also covers composite films made from different plastic films.

4. Symbols for Units

Unit	Symbol
metre	m
micrometre or micron	μm... μ
ångström	Å
inch	in
foot	ft
yard	yd
mile	mile
square metre (similarly for square centimetre, etc.)	m^2
square inch (similarly for square foot, etc.)	in^2

cubic metre(similarly for cubic centimetre, etc.)	m^3
cubic inch(similarly for cubic foot, etc.)	in^3
litre	l
gallon	gal
second (time)	s
minute (time)	min
hour	h
day	d
degree: minute: second (angle)	° ′ ″
radian	rad
steradian	sr
radian per second	rad/s
cycle per second*	c/s
revolution per minute	rev/min
gramme	g
kilogramme	kg
pound	lb
slug	slug
ton	ton
dyne	dyn
newton	N
pound-force(similarly for kilogramme-force, etc.)	lbf
bar (10^6 dyn/cm^2)**	bar
millibar**	mb
atmosphere, standard	atm
millimetre of mercury (conventional)***	mmHg
joule	J
erg	erg
kilowatt hour	kWh
foot pound-force	ft lbf

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*The hertz (symbol Hz) is used as the name of this unit in Continental literature in accordance with recommendations of the I.E.C. and the ISO.

**The unit symbol "bar" is recommended by the Conférence Générale des Poids et Mesures and the International Organization for Standardization. In meteorology it is the internationally accepted practice to use the symbol mb for millibar.

***Equal to the torr, i.e. 1 atm/760, to within 1 part in 7 million.

calorie	cal
British thermal unit	Btu
watt	W
horsepower	hp
neper	Np

The unit symbol here given is that adopted by the ISO for general scientific and technological purposes. In telecommunication practice the unit symbol N is used except that, where there is risk of confusion with the symbol N for newton, the symbol Np is used for neper. This is in accordance with a recommendation of the Comité Consultatif International Télégraphique et Téléphonique.

decibel	dB

dB is recommended here and in Part 1 of B.S.1991, and by the ISO, as the general symbol for this unit, It is used in acoustics. The symbol db is used in telecommunication. The latter form is used by the Comité Consultatif International Télégraphique et Téléphonique and the Comité Consultatif International Radio. A number of units relating to the decibel and used in telecommunication have their symbols based on db. These units and their symbols are given at the end of this list.

degree (temperature value)	
degree Celsius*	$^\circ$C
degree Kelvin	$^\circ$K
degree Fahrenheit	$^\circ$F
candela	cd
lumen	lm
lux	lx
nit	nt

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*Formerly called 'centigrade'. The use of the name 'centigrade' for this purpose was abandoned by the Conférence Générale des Poids et Mesures in 1948.

hydrogen ion exponent	pH
coulomb	C
ampere	A
volt	V
ohm	Ω
mho (reciprocal ohm)*	mho, Ω^{-1}
ampere-turn	At
ampere hour	Ah
electronvolt	eV
volt ampere	VA
reactive volt ampere (var)	VAr
perv	perv
farad	F
henry	H
weber	Wb
gilbert	Gb
oersted	Oe
maxwell	Mx
gauss	Gs
binary digit	bit
erlang	E
decibel relative to 1 volt per metre	db (V/m)
decibel relative to 1 watt	dbW, db(W)
decibel relative to 1 milliwatt	dbm, db(mW)
signal-to-test level ratio (decibel relative to 1 milliwatt at a point of zero reference level)	dbm0
decibel relative to the specified reference level	dbr

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*The siemens (symbol S) is used as the name of this unit in Continental literature in accordance with recommendations of the I.E.C. and the ISO.

EXERCISES

1. Shorten the following sentences:
   1) This step was taken in order that everyone might be satisfied.
   2) We went to the lecture early in order that we might get good seats.
   3) Follow the directions carefully in order that you may avoid unnecessary errors.
   4) They stood up so that they might see better.
   5) I left the letter in the office so that she might read it.
   6) Fifty copies of the book were bought so that each student might have one.

2. Translate into German:

The fundamental questions to be treated in the present paper can be broadly divided into two general categories. The main conclusion to be drawn from this analysis is the following. There remain two factors to be taken into consideration. The advantages to be gained from the introduction of this procedure would be considerable. The values obtained were then compared with the theoretical values to be expected. The operation to be performed can be best handled with a certain quite restricted number of components.

3. Translate into English:
   1) Als Isolationswiderstand gilt jeder elektrische Widerstand eines Isolierstoffes zwischen zwei Elektroden. Hierbei ist zu unterscheiden zwischen dem Isolationswiderstand im Innern und an der Oberfläche des Isolierstoffes.
   2) Isolierfolien sind Kunststoff-Folien, die für elektrische Isolierungen verwendet werden. Sie werden auch Elektroisolierfolien genannt. Unter diesen Begriff fallen auch Verbundfolien, die unter Verwendung verschiedener Kunststoff-Folien hergestellt werden.

Lesson Fifteen

CHEMISTRY

Atomic Weights

An atomic weight is the average weight of an atom of an element based on a unit of 1/12 the weight of the carbon isotope that has the weight of 12. An Oxygen unit is $\frac{1}{16}$ of the weight of an atom of oxygen. There are many ways in which the value of an atomic weight may be checked such as by its specific heat, its place in the periodic system, and others.

The molecules of helium, argon, the other gases of the zero group in the periodic table, and most metals in the vapour state consist of a single atom, so that atomic weights are identical with molecular weights for these substances. Oxygen, nitrogen, chlorine and hydrogen, or, in general, any element whose condition in the vapour state is indicated by the symbol E_2, have atomic weights that are half the molecular weights.

The atomic weights of elements that do not form gaseous compounds are determined from exact chemical analysis of their compounds, together with supplementary data that show the formula of the compound.

Although the most direct method of determining precise atomic weights would be the analysis or synthesis of oxides, very few of the elementary oxides may be prepared in a sufficiently pure form for this purpose. Metallic halides are more readily purified, and ratios such as ECl:Ag may be used to determine atomic weights if the atomic weights of Cl and Ag are accepted. But these atomic weights involve those of other elements. The basic quantities are the atomic weights of 11 elements, which are related to one another through 71 ratios that have been most carefully determined. From these ratios we derive 43 estimates of the atomic weight of silver, 32 for chlorine, 16 for bromine, 22 for nitrogen, etc., and finally determine the basic values of the 11 atomic weights: H, C, N, S, Cl, Br, J, Li, Na, K, and Ag.

Avogadro's Law

A provisional statement of this important law, which will require some modification to put it into exact form, is that equal volumes of gases at the same temperature and pressure contain the same number of molecules. If this law is accepted, we may determine the relative weights of the molecules of the gases by comparing the weights of equal volumes at the same temperature and pressure. In order to put these comparisons on a numerical scale, the next step is obviously to select some substance as a reference standard, and chemists by common consent have adopted 32 as the "molecular weight" of oxygen. Since they employ the gram as a unit of weight, 32 grams of oxygen is therefore accepted as a "gram-molecular weight", or a gram molecule. On account of the extensive use of this term, it has been abbreviated to "mole", which is written without a period. It is not an abbreviation of the word "molecule", but a separate new word meaning gram-molecular weight or formula weight.

A gram-molecular weight of a gas is that weight of it which occupies the same volume as 32 grams of oxygen at the same temperature and pressure. If we define a gram-molecular volume of gas as the volume occupied by 32 grams of oxygen, we may then define the gram-molecular weight of any gas as that weight which fills a gram-molecular volume. At 1 atm pressure a gram-molecular volume of gas is 22.4 litres at 0°C, and we may, of course, compute the weight of a gram-molecular volume from the weight of any convenient volume.

Avogadro's law is an example of a "limiting law" which becomes more nearly exact as the pressure at which the gases are compared is reduced, but which may be largely in error at high pressures or near the condensation point of a gas. For "permanent" gases at 1 atm and ordinary temperatures the number of molecules per unit volume is the same within about 1 per cent. But the fractional expansion for a given pressure decrease at constant temperature is not quite the same for all gases, and therefore precise molecular weights may be determined through Avogadro's law only at low pressures. We may now state Avogadro's law in a workable and exact form: equal volumes of gases at the same temperature and the same very low pressure contain the same number of molecules.

The necessity for this form of statement may be illustrated by the ratio of the density of N_2O to that

of oxygen at $0^{\circ}C$ which is $\frac{1.9782}{1.4289} = 1.3844$ for the gases at 1 atm

and $\frac{0.9855}{0.7142} = 1.380$ at $\frac{1}{2}$ atm. The limit that this ratio of densities at equal pressures approaches as the pressure approaches zero is 1.3765. Hence, 32.000 X 1.3765 = 44.020 is the molecular weight of N_2O at such a low pressure that Avogadro's law is exact.

Mendeleev's Periodic Law

Final evolution of the periodic classification came in 1869 as a result of the efforts made by Dimitri Mendeleev. Acceptance of the Mendeleev's classification must be regarded as the beginning of the true renaissance in chemical thought. For the first time variations among the properties of the elements and their compounds were fitted into a logical pattern and it was no longer necessary to treat an element as an individual completely detached from and unrelated to its neighbours. The bases of all modern developments in chemistry were laid in Mendeleev's table and the developments in atomic structure resulted directly or indirectly from consideration of the regularities existing among the elements and made apparent by his periodic classification.
The original statement of Mendeleev (1869) includes practically the whole contents of the Periodic Law. It is given in eight paragraphs:

(1) The elements, if arranged according to their atomic weights, exhibit an evident periodicity of properties.
(2) Elements which are similar as regards their chemical properties have atomic weights which are either of nearly the same value (platinum, iridium, osmium), or which increase regularly (potassium, rubidium, caesium).

(3) The arrangement of the elements, or of groups of elements, in the order of their atomic weights, corresponds with their so-called valencies.

(4) The elements which are the most widely distributed in nature have small atomic weights, and sharply defined properties. They are therefore typical elements.

(5) The magnitude of the atomic weight determines the character of an element (and those of its compounds).

(6) The discovery of many yet unknown elements may be expected, for instance elements analogous to aluminium and silicon, whose atomic weights would be between 65 and 75. (These have since been discovered).

(7) The atomic weight of an element may sometimes be corrected by the aid of a knowledge of those of the adjacent elements. (This has been done in several cases).

(8) Certain characteristic properties of the elements can be foretold from their atomic weights.

The Periodic System

Mendeleev arranged the elements in a table, called the periodic table, or periodic system. The periodic table in many forms has been used to help to solve research problems of industrial importance. Several of the light metals and their alloys that are used in the construction of modern automobiles, jet engines, and aircraft were first studied because of their position in the periodic table.

In the petroleum industry, research workers had spent considerable time and money looking for a compound to add to gasoline that would impart anti-knock properties. When they started correlating the properties that they desired with the properties of various elements in the periodic table, they were able to make a more intelligent search. After trying several compounds of elements with desirable properties, they finally settled on tetraethyl lead as an anti-knock compound to be added to the modern ethyl gasoline.

Solutions

Solid sugar, or salt, when added to water, dissolves and forms a homogeneous solution. Liquid alcohol and water also mix in all proportions to form solutions. It is generally possible, by suitable means, to separate again the constituents of solutions, one method being by distillation.

Solutions of Gases in Liquids.- If a flask and delivery tube are completely filled with tap water, and the flask is heated, bubbles of gas appear, which pass out of the delivery tube under water, and will be found to be mainly air; such water, therefore, contains dissolved gas.
Solids are also capable of dissolving gases; thus palladium dissolves hydrogen, forming a *solid solution*. Solids may also dissolve solids: if a piece of gold leaf is pressed on a freshly-scraped piece of lead, the gold slowly penetrates into the latter, as may be proved by scraping off successive layers after a long time and analysing them.

Solutions of Liquids in Liquids.- Some liquids, such as water and mercury, are practically, though probably not absolutely, *immiscible*; others, such as water and sulphuric acid, are *completely miscible*. In some cases, such as ether and water, each liquid dissolves a limited amount of the other, and the liquids are *partially miscible*.

Solutions of Solids in Liquids.- The most important class of solutions is formed by dissolving solids in liquids. Common salt added in successive small amounts to water dissolves up to a certain point; after this no more salt passes into solution, but settles out unchanged. A solution which can exist in equilibrium with excess of solute under given conditions (e.g., at a fixed temperature) is called a *saturated solution*: salt (solid) $\rightleftarrows$ salt (dissolved).
The *concentration* of a solution is expressed in various ways; usually as the number of grammes of solute contained in 100 g of solution. The concentration of a solution saturated

with a solute is called the solubility of the latter; it is the maximum weight in grammes of solid dissolved by 100 g of solution at the given temperature, in presence of the solid salt. For common salt in water it is 26.3 at 15°C. The solubility depends

(1) on the chemical characters of solute and solvent,

(2) on temperature, and

(3) to a slight extent on pressure, in some cases (sodium chloride) increasing, in other cases (ammonium chloride) decreasing, with increase of pressure.

The solubility usually increases with the temperature. In a few cases, such as sodium chloride, it is nearly independent of temperature, and in others, such as calcium sulphate above 40° C, it diminishes with rise of temperature.

Dissociation

Dissociation means the separation of a molecule into its original constituent atoms. Dissociation is of two kinds and there are

(1) thermal dissociation and

(2) electrolytic dissociation.

By thermal dissociation is meant the decomposition or breaking down of a compound when the temperature of it is increasing, and the recombination or building up of it when the temperature is decreasing. As an example, when water vapour (H_2O) is sufficiently heated it is decomposed into hydrogen (H) and oxygen (O) and when the heat is reduced they recombine again and reform water (H_2O), thus:

$$2H_2O \rightleftarrows 2H_2 + O_2$$

By electrolytic dissociation is meant that when certain substances are dissolved in water (H_2O) their molecules break up into ions and these give the solution the necessary properties to conduct an electric current. The acids, bases and salts have these inherent properties and they are, for this reason, called electrolytes; when they are dissolved in water (H_2O) they form what is termed an electrolytic solution, or just electrolyte for short.

The Conductivity of Electrolytic Solutions

If a pair of metal rods, or electrodes, as they are called, are immersed in electrolytic solution and these are connected with a battery or other source of direct electric current, the ions of the metals and that of hydrogen (H) will be attracted to the cathode or negative electrode and the ions of the acid radicals and the hydroxyl group will be attracted to the anode or positive electrode. When these ions reach their respective electrodes the atoms give up their electric charges and again take on their ordinary properties.

Now there are two chief factors that determine the value of the conductivity of an electrolytic solution and these are

(1) the number of ions there are in it and

(2) the speed with which the ions move. The first factor depends on the number of molecules that are dissociated in it for the more ions there are, the greater will be the conductivity of the solution. The second factor depends on the speed with which the ions move and this, in turn, depends on the valence of them since ions that have a valence of two or more will carry more electric charges than those having a valence of only one. The factor also depends on the specific nature of the individual ions. Thus, H^+ and Na^+ are the same valence ions, yet H^+ migrates to the cathode with a greater speed than does Na^+.

Chemical Equilibrium

A chemical reaction, e.g.:

$$A+BC=AB+C$$

may proceed only to a certain point, because the opposed reaction:

$$AB+C=A+BC$$

can often take place under the same conditions and at the same time as the direct reaction.

A state of equilibrium is then reached, when the two opposing reactions balance each other, i.e., proceed with equal speeds. This is denoted by:

$$A+BC \rightleftarrows AB+C$$

The same state of equilibrium is reached, for example, on heating hydrogen iodide at 444°C for a sufficient time as on heating a mixture of hydrogen and iodine vapour, in equivalent proportions, at the same temperature:

$$H_2+I_2 \rightleftarrows 2HI$$

In many cases a reaction appears to go to completion instead of to a state of equilibrium. This often results from some disturbance of the equilibrium state, by one or more of the products of the reaction being removed from the sphere of action by their volatility or insolubility. As soon as they leave the system, passing into the gaseous state or depositing as solids, they cease to exert any influence and the reaction by which they are produced, being no longer opposed, cannot become balanced and proceeds until the change becomes nearly if not quite complete.

QUESTIONS

1) What is the difference between organic and inorganic chemistry?
2) What is a compound?
3) What is an element?
4) What are the English names of some elements?
5) Of what elements is water composed?
6) What is the valency of hydrogen?
7) What is the atomic weight of hydrogen?
8) By what endings are the names of salts modified?
9) Is carbon dioxide lighter or heavier than air?
10) What is dilute sulphuric acid?
11) What is meant by thermal dissociation? electrolytic dissociation?

SYMBOLS FOR PHYSICAL QUANTITIES

Term	Symbol
1. General Constants	
speed of light	c
Avogadro's number	N
gas constant, molar (universal)	R...R
Boltzmann's constant	k
Faraday's constant	F
charge of electron	$-e$
mass of electron	m
Planck's constant	h
Stefan-Boltzmann constant	σ
standard acceleration due to gravity	g_n
2. Chemical Composition and Reaction	
atomic number	Z
atomic weight	A
molecular weight	M
number of molecules	N
number of moles	n
stoicheiometric number of molecules	ν
degree of dissociation	α
mole fraction	x
concentration	c, C
concentration, molar, of substance X	$c_x, C_x, [X]$
molality	m
surface concentration	Γ
velocity constant of reaction	k
activation energy	E
equilibrium constant of reaction	K
diffusion coefficient	D

3. Electrochemistry

potential; potential difference	V
electric current	I
electric charge	Q
resistance	R
inductance	L
capacitance	C
energy, electrical	W
power	P
degree of dissociation	α
valency of an ion	z (negative for anions)
ionic strength	I
electrolytic conductivity (or specific conductance)	κ
conductance, equivalent or (with subscript m) molar	Λ
ionic conductance, equivalent	$\Lambda \ldots l$ (with subscript)
transport number	t, T (with subscript)
electromotive force	E
single electrode potential	E (with subscript)
electrolytic polarization, overpotential	η
electrokinetic (zeta) potential	ζ

4. Technical Chemistry

Spectrophotometry

absorption coefficient	a, μ
extinction coefficient	k, K
molecular extinction coefficient	ϵ
optical density	d
extinction (=d)	E

Chromatography

distance travelled by substance sought, divided by distance moved by solvent front	R_F

TABLE OF CHEMICAL ELEMENTS, SYMBOLS AND ATOMIC WEIGHTS

Name	Symbol	Atomic number	Atomic weight	Name	Symbol	Atomic number	Atomic weight
Actinium	Ac	89	--	Francium	Fr	87	--
Aluminium	Al	13	26·98	Gadolinium	Gd	64	157·26
Americium	Am	95	--	Gallium	Ga	31	69·72
Antimony	Sb	51	121·76	Germanium	Ge	32	72·60
Argon	Ar	18	39·944	Gold	Au	79	197·0
Arsenic	As	33	74·91	Hafnium	Hf	72	178·50
Astatine	At	85	--	Helium	He	2	4·003
Barium	Ba	56	137·36	Holmium	Ho	67	164·94
Berkelium	Bk	97	--	Hydrogen	H	1	1·0080
Beryllium	Be	4	9·013	Indium	In	49	114·82
Bismuth	Bi	83	209·00	Iodine	I	53	126·91
Boron	B	5	10·82	Iridium	Ir	77	192·2
Bromine	Br	35	79·916	Iron	Fe	26	55·85
Cadmium	Cd	48	112·41	Krypton	Kr	36	83·80
Caesium	Cs	55	132·91	Lanthanum	La	57	138·92
Calcium	Ca	20	40·08	** Lead	Pb	82	207·21
Californium	Cf	98	--	Lithium	Li	3	6·940
Carbon	C	6	12·011	Lutetium	Lu	71	174·99
Cerium	Ce	58	140·13	Magnesium	Mg	12	24·32
Chlorine	Cl	17	35·457	Manganese	Mn	25	54·94
Chromium	Cr	24	52·01	Mendelevium	Md	101	--
Cobalt	Co	27	58·94	Mercury	Hg	80	200·61
Copper	Cu	29	63·54	Molybdenum	Mo	42	95·95
Curium	Cm	96	--	Neodymium	Nd	60	144·27
Dysprosium	Dy	66	162·51	Neon	Ne	10	20·183
Einsteinium	Es	99	--	Neptunium	Np	93	--
Erbium	Er	68	167·27	Nickel	Ni	28	58·71
Europium	Eu	63	152·0	Niobium	Nb	41	92·91
Fermium	Fm	100	--	Nitrogen	N	7	14·008
Fluorine	F	9	19·00	Nobelium	No	102	--

** Lawrencium, symbol Lr (Lw), atomic number 103; two isotopes have been discovered, mass number 257 or 258 and mass number 256.

Osmium	Os	76	190·2	Tantalum	Ta	73	180·95
Oxygen	O	8	16	Technetium	Tc	43	--
Palladium	Pd	46	106·4	Tellurium	Te	52	127.61
Phosphorus	P	15	30.975	Terbium	Tb	65	158·93
Platinum	Pt	78	195.09	Thallium	Tl	81	204·39
Plutonium	Pu	94	--	Thorium	Th	90	232·05
Polonium	Po	84	--	Thulium	Tm	69	168·94
Potassium	K	19	39·100	Tin	Sn	50	118·70
Praseodymium	Pr	59	140·92	Titanium	Ti	22	47·90
Promethium	Pm	61	--	Tungsten	W	74	183·86
Protactinium	Pa	91	--	Uranium	U	92	238·07
Radium	Ra	88	--	Vanadium	V	23	50·95
Radon	Rn	86	--	Xenon	Xe	54	131·30
Rhenium	Re	75	186·22	Ytterbium	Yb	70	173·04
Rhodium	Rh	45	102·91	Yttrium	Y	39	88·92
Rubidium	Rb	37	85·48	Zinc	Zn	30	65·38
Ruthenium	Ru	44	101·1	Zirconium	Zr	40	91·22
Samarium	Sm	62	150·35				
Scandium	Sc	21	44·96				
Selenium	Se	34	78·96				
Silicon	Si	14	28·09				
Silver	Ag	47	107.880				
Sodium	Na	11	22·991				
Strontium	Sr	38	87·63				
Sulphur	S	16	32·066*				

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*Because of natural variations in the relative abundance of the isotopes of sulphur the atomic weight of this element has a range of ± 0·003.

IMPORTANT TERMS

antiknock compound	Antiklopfmittel n
bromine ('brəumiːn)	Brom n
caesium ('siːzjəm)	Zäsium n
chlorine ('klɔːriːn)	Chlor n
constituent	Gefügebestandteil m; Komponente f
correlate, to	korrelieren, in Wechselbeziehung setzen, zuordnen
decomposition	Zersetzung f, Dissoziation f; Auflösung f; Zerfall m; Umsetzung f; Zerlegung f
dissociation	Dissoziation f, Aufspaltung f, Zerlegung f
distillation	Destillation f
electrolyte (i'lektrəulait)	Elektrolyt m, Lauge f
estimate	Schätzung f, Kosten(vor)anschlag m, Ueberschlag m
flask	(ch) Flasche f, Kolben m, Flakon m; (metall) Formkasten m
gold leaf	Blatt-, Blütengold n; Goldblatt n
halide ('hælaid)	Halogenid n, Salz n einer Halogenwasserstoffsäure
helium ('hiːljəm)	Helium n
hydrogen ('haidridʒən)	Wasserstoff m
hydrogen iodide (...'aiəudaid)	Jodwasserstoff m
iridium (ai'ridiəm)	Iridium n
nitrogen ('naitrədʒən)	Stickstoff m
osmium	Osmium n
oxide ('ɔksaid)	Oxid n; (metall) Zunder m
oxygen ('ɔksidʒən)	Sauerstoff m
platinum ('plætinəm)	Platin n
potassium	Kalium n
rubidium (ru(ː)'bidiəm)	Rubidium n
scrape, to	schaben; kratzen; abreiben
sodium chloride (...'klɔːraid)	Natriumchlorid n, Kochsalz n, Steinsalz n

solubility - Löslichkeit f; Lösbarkeit f
solute (sə'ljuːt) - (auf)gelöster Stoff
solution - (ch, math) Lösung f; Auflösung f
solvent - Lösungsmittel n, Auflösungsmittel n, Lösemittel n
state of equilibrium - Gleichgewichtszustand m
tap water - Leitungswasser n
tetraethyl lead - Bleitetraäthyl n
valency - Valenz f, Wertigkeit f; Ladungszahl f

GRAMMAR and NOTES

1. The discovery of many yet unknown elements may be expected, for instance elements analogous to aluminium and silicon, whose atomic weights would be between 65 and 75.
A freshly scraped piece of lead.
Common salt added in successive small amounts to water dissolves up to a certain point.

Partizipien können im Englischen wie im Deutschen zu reinen Adjektiven werden, sobald sie ihre verbale Funktion aufgeben, z.B.:

a surprising discovery	eine überraschende Entdeckung
an interesting story	eine interessante Erzählung

Wenn ihre Bedeutung es zulässt, können sie wie andere Adjektive

a) sich steigern lassen:	more (most) surprising -- überraschend-er,-ste;
b) zu Adverbien werden:	surprisingly fresh -- überraschend frisch;
c) very zu sich nehmen:	a very interesting story.

Attributive Adjektive und Partizipien stehen in der Regel wie im Deutschen vor dem zugehörigen Substantiv:

the highest possible number	die grösstmögliche (An-)Zahl
an unexpected answer	eine unerwartete Antwort

ebenso in Verbindung mit Adverbien:

a very hard-working boy	ein sehr fleissiger Junge
an exceptionally clever girl	ein ungewöhnlich kluges Mädchen

Gewisse Partizipien wie known und read können nur in Verbindung mit einem Adverb attributiv vor ein Substantiv treten:

a well-known writer	ein bekannter Schriftsteller
a well-read man	ein belesener Mann
ähnlich: an unheard-of event	ein unerhörtes Ereignis

Anmerkung: Vor das Substantiv treten attributive Perfektpartizipien oft nur bei der Zusammensetzung mit einem Adverb der Art und Weise:

a new-built house	ein neugebautes Haus
well-tried methods	erprobte Methoden

Aehnlich wie im Deutschen können Stoffnamen unverändert als Attribut vor ein Substantiv treten. Während im Deutschen jedoch eine Wortverschmelzung eintritt (z.B. "Bleistift, Goldstück), werden die Stoffbezeichnungen im Englischen hier wie Adjektive gebraucht (vgl. Akzent):

a 'lead 'pencil, a 'gold 'coin.

Eine Reihe von Stoffnamen wie copper, iron, tin kann nur in der Form des Substantivs verwendet werden, z.B.:

a copper coin	eine Kupfermünze, kupferne Münze
iron gates	eiserne (oder: Eisen-) Tore
an iron will	ein eiserner Wille (= ein Wille wie Eisen)

Auch Beispiele wie aluminium, coal, coke "Koks", iridium usw. gehören (in Uebereinstimmung mit ihren deutschen Entsprechungen) dazu.

In vielen Fällen besteht daneben aber die Möglichkeit, adjektivische Ableitungen auf -y (air-airy, gas-gassy, hair-hairy usw. oder (seltener) auf-en (wooden "Holz-, hölzern"), woolen ("Woll-, wollen") sowie nur noch in übertragener Bedeutung (golden "golden", silken "seidig", waxen "wächsern") zu verwenden.

Zu den Bedeutungsunterschieden vgl. etwa:

a gold coin; a gold watch	ein Goldstück; eine goldene Uhr
golden hair; golden wedding	goldenes (oder: Gold-)Haar; goldene Hochzeit
a silk hat (=top hat)	ein Seidenhut (= Zylinder)
silken hair	seidiges Haar
a silky (or: silken) voice	eine weiche (geschmeidige) Stimme

Abweichend vom Deutschen bleiben Ortsnamen in attributiver Verwendung stets unverändert. Sie bilden keine besonderen Adjektivformen:

London Bridge	die Londoner Brücke
Berlin newspapers	Berliner Zeitungen

Als Substantive mit-er merke:

the Londoner(s), the New Yorker(s).

Dagegen werden Ländernamen im allgemeinen nicht vor Substantiven verwendet, da hier besondere Adjektivformen zur Verfügung stehen: England-English; France-French; Germany-German, usw.

Nachstellung des Adjektivs (Partizips).

A. Nachgestellt wird das Adjektiv oder Partizip abweichend vom Deutschen, wenn es noch eine Ergänzung bei sich hat, wobei es meist als verkürzter Relativsatz aufgefasst werden kann:

There are many suns brighter than our sun.	Es gibt viele hellere Sonnen als die unsere.
The train standing at platform one is the Glasgow train leaving at two ten.	Der auf Bahnsteig eins stehende Zug ist der um zwei Uhr zehn nach Glasgow abfahrende Zug.

Auch längere Massangaben treten hinter das Substantiv:

a boy six years old	ein sechs Jahre alter Junge
aber auch: a six-year-old boy	ein sechsjähriger Junge.

Gelegentlich finden sich auch Adjektive in Verbindung mit as, however, so, too oder more, most hinter dem Substantiv:

All that we do has to be learnt, even things the most natural.	Alles, was wir tun, muss gelernt werden, selbst die natürlichsten Dinge.

Why should he come to an end so disastrous?	Weshalb sollte er zu einem so unglücklichen Ende kommen?

B. Einfache (nicht erweiterte) Partizipien, deren verbaler Charakter bewahrt ist, werden gleichfalls nachgestellt. Sie können ebenfalls zu einem Relativsatz erweitert werden:

The texts chosen are announced in advance.	Die ausgewählten Texte werden vorher angesagt.
This is about the only place left.	Dies ist so ziemlich der einzige übriggebliebene Platz.
for reasons unexplained	aus ungeklärten Gründen
the address given	die angegebene Anschrift
the topics discussed	die besprochenen Themen
the person spoken to	der (die) Angeredete

2. Equal volumes of gases at the same temperature and the same very low pressure contain the same number of molecules. (Avogadro's Law)
Like charges repel, unlike charges attract each other. Stress is proportional to strain.
Metals expand when heated and contract when cooled.
Das einfache Präsenz (The Simple Present) steht wie das deutsche Präsens

a) für wiederholte, gewohnheitsmässige Handlungen
ebenso (als "zeitloses" Präsens) für allgemeingültige Feststellungen, Naturgesetze, Definitionen, sowie für zeitlich nicht eingeschränkte Handlungen oder Zustände:

The sun rises in the east and sets in the west.	Die Sonne geht im Osten auf und im Westen unter.

b) für konkrete Einzelhandlungen der Gegenwart, wenn der Sprechende nur angeben will, was geschieht, insbesondere bei mehreren aufeinanderfolgenden Handlungen und bei Zustandsverben:

The teacher goes to her desk and puts down her books.	Die Lehrerin geht zu ihrem Tisch und legt ihre Bücher hin.
Do you see what I mean?	Verstehen Sie, was ich meine?
It doesn't matter.	Es macht nichts.

Anmerkung: Verben der Sinneswahrnehmung werden hierbei oft mit can verbunden:

Can you hear the bell?	Hören Sie die Klingel?
Can you see anything?	Sehen Sie etwas?

c) für eine zukünftige Handlung an Stelle des Futurs

1) stets in konditionalen und temporalen Nebensätzen nach if, in case, unless und when, while, after, before, as soon as, as long as, till, until, directly usw.
Die futurische Bedeutung geht in der Regel aus dem Tempus der Hauptsätze hervor:

If he comes, I'll tell him.	Falls er kommt, werde ich es ihm sagen.
He won't do it unless you ask him.	Er wird es nicht tun, wenn du ihn nicht (darum) bittest.
When I meet her, I shall speak to her.	Wenn ich sie treffe, werde ich mit ihr sprechen.

2) in Verbindung mit futurischen Zeitangaben vor allem für feststehende Termine:

We meet her next Friday.	Wir treffen sie nächsten Freitag.
When does he go back?	Wann fährt er zurück?
Tomorrow night you have your meeting, don't you?	Morgen abend haben Sie ja wohl Ihre Versammlung?

Anmerkung: Auch nach to hope findet sich das einfache Präsens mit futurischer Bedeutung:

I hope the postman comes before I leave for work.	Hoffentlich kommt der Postbote, ehe ich zur Arbeit gehe.

Nach einigen Verben wie forget, hear, learn steht das einfache Präsens an Stelle des Perfekts:

I forget the name.	Ich habe (im Augenblick) den Namen vergessen.
I can't tell him at once because I hear he is away at present.	Ich kann es ihm nicht sofort sagen, weil er, wie ich gehört habe, zur Zeit nicht da ist.
He is newly married, I learn.	Er ist jung verheiratet, wie ich erfahren habe.

aber:

I have forgotten where he lives.	Ich habe (ganz) vergessen, wo er wohnt.

Anmerkung: Als sogenanntes "historisches Präsens" (für Handlungen in der Vergangenheit) findet sich das Simple Present gewöhnlich nur noch in volkstümlicher Rede.

3. While the liquids are reacting, heat is evolved. This year we are testing a new control system.
From the start the engine is running under control.
When we are considering these problems, we need to keep in mind the cost of the operations involved.

Die Verlaufsform des Präsens bezeichnet

a) Tätigkeiten, die entweder im Augenblick des Sprechens oder im gegenwärtigen Zeitraum vor sich gehen:

What are you looking at?	Was betrachten Sie denn gerade?
Do you understand what I am saying?	Verstehen Sie, was ich (gerade) sage?
I am beginning to understand.	Ich begreife es jetzt allmählich.
His sister is living in London	Seine Schwester lebt (zur Zeit) in London.

English words are constantly changing their functions.	Im Englischen verändern die Wörter ständig ihre Funktion.

Anmerkung: Den augenblicklichen Ablauf kann die Verlaufsform nach der Konjuktion when auch bei wiederholter Tätigkeit bezeichnen:

It's when you are sending a letter that you need to be exact.	Genau sein muss man immer, sobald man einen Brief schickt.

b) In futurischer Bedeutung bezeichnet die Verlaufsform des Präsens gewöhnlich nahe bevorstehende, durch Verabredung oder Vereinbarung festgelegte Handlungen. Das zeitliche Verhältnis wird meist durch entsprechende adverbiale Bestimmungen verdeutlicht:

We are having a small party next week.	Nächste Woche geben wir eine kleine Gesellschaft.
What are we having for supper?	Was essen wir denn (heute) als Abendbrot?
We are going abroad in September.	Im September fahren wir ins Ausland.

Als "vergegenwärtigte Zukunft" kann die Verlaufsform des Präsens auch hier als progressiver Aspekt aufgefasst werden.
Die Verlaufsform des Präsens nach When....? und How long....? hat stets futurische Bedeutung:

When is he coming home?	Wann kommt er nach Hause?
How long are you staying here?	Wie lange werden Sie hierbleiben?

Der intensive Aspekt bei wiederholten Handlungen

Einer besonderen Behandlung bedarf die Verlaufsform noch in Verbindung mit Zeitadverbien wie always, constantly, continually bei unregelmässig wiederholten Handlungen. Wie die folgenden Beispiele unter 1 zeigen, liegt oft (vor allem im Präsens und Präteritum) ein deutlicher Bedeutungsunterschied gegenüber den Formen des einfachen Aspekts (s.2.) vor:

1. a)	He's always talking of how hard up he is	Er redet aber auch immer davon, wie schlecht es ihm geht.
	Other people are constantly doing things which I think ridiculous.	Andere Leute tun aber auch dauernd Dinge, die ich als lächerlich ansehe.
b)	Listeners are always asking him to talk about punctuation.	Die Hörer bitten ihn immer wieder, über Zeichensetzung zu sprechen.
	The same thing was constantly happening to herself.	Das gleiche passierte ihr (selber) dauernd.
c)	You're always seeing something strange!	Du siehst aber auch immer etwas Seltsames!
	I suppose this is one of the new gadgets I'm always seeing advertised.	Dies ist wohl einer der neuen technischen Artikel, die ich immer angekündigt finde.
2.	You know I always tell you the truth.	Sie wissen, dass ich Ihnen immer die Wahrheit sage.
	You always say the right thing.	Sie sagen immer das Rechte.
	He always keeps old letters.	Er bewahrt immer alte Briefe auf.

In diesen Beispielen ist die Verlaufsform bei unregelmässig wiederholten Handlungen gleichfalls als Ausdruck des intensiven Aspekts zu verstehen, durch den der Sprechende seiner Aussage entweder

a) einen bestimmten Gefühlswert (z.B. Anerkennung, Vorwurf, Unwillen) oder

b) besonderen Nachdruck verleiht. Wie auch sonst beim intensiven Aspekt können hier auch diejenigen Verben, die in der Regel nur im einfachen Aspekt gebräuchlich sind, in der Verlaufsform verwendet werden c).- Demgegenüber stellt der einfache Aspekt (2.) rein sachlich eine ständige Gewophnheit oder Eigenschaft fest.

4. Bei chemischen Formeln und Gleichungen werden die Buchstaben separat ausgesprochen. Zum Beispiel:

CHCl und NaOH werden als Gruppen von vier separaten Buchstaben gelesen; Zn und Mn werden als Gruppen von zwei separaten Buchstaben gelesen.

5. Word Study

electrolysis	- Elektrolyse f
electrolysis in the dry way	- Schmelzflusselektrolyse f
electrolyte	- Elektrolyt m, Lauge f
electrolyte dissociation constant	- Dissoziationskonstante f
electrolytic	- elektrolytisch
electrolytic analysis	- elektrolytische Analyse, Elektroanalyse f
electrolytic water-tester	- (elektrolytischer) Speisewasserprüfer m
electrolytical pickling bath	- elektrolytisches Beizbad
electrolytically oxidized	- eloxiert
electrolyze, to	- elektrolysieren, durch Elektrolyse zersetzen
electrolyzer	- Elektrolyseur m

Electrolysis is the separation of positive and negative ions in a conducting solution by means of the attraction of a positively and negatively charged terminals (electrodes) immersed in the solution.

Electrolyte is a solute which dissociates into ions, rendering

the solution electrically conductive. More specifically, it is the acid or alkaline solution used in batteries, chemical rectifiers, and certain types of condensers; any compound that ionizes in water to form a conducting solution.

Electrolytic pickling is a method of pickling in which current is passed through the solution.

Electrolyzer is an industrial electrolytic cell.

EXERCISES

1. Put the verbs in brackets into suitable forms:
   When a substance with such properties (to be produced), the problem (to be solved). The journal (to accept) a paper provided it (to make) a new contribution to the present knowledge. We (to follow) this course as long as we (to find) it convenient. After he (to become) familiar with his new work he no longer (to require) detailed instructions. If the candidate (not to meet) the requirements he (to be allowed) to take the examination in the following term. We (to consider) every factor before a decision (to be taken). I (to send) you a copy as soon as the dictionary (to come out). Until the Board (to decide) on a new course we (to continue) according to the original plan. I (to try) to help you whenever you (to be) in doubt or (to need) assistance. The paper should be divided into the following sections unless the author (to have) good reasons for another arrangement.

2. Put the verbs in brackets into the Present Tense (simple or progressive forms):
   At present the last argument (to gain) ground. The town (to change) rapidly its appearance. Direct evidence (to lack). It (to freeze) hard. This fact (to provide) at least some information on the point in question. He never (to speak) about his difficulties. This year I (to work) on a linguistic subject. At present he (to work) in the field. He usually (to come) at half past seven. We (to leave) next week. Tomorrow I (to study)

the whole day in the library. We (to go) abroad in September. We (to have) a small party next week. Our export (to increase).

3. Translate into German:

The name of a compound built up of two elements is made to end in -ide, the name of the non-metallic part being thus modified, e.g.

CaO	Calcium oxide
CaC_2	Calcium carbide
$NaCl$	Sodium chloride.

To distinguish between two or more compounds of the same elements, the prefixes mon(o)-, di-, tri-, tetr(a)-, pent(a)-, are used, e.g.

N_2O	Nitrogen monoxide
N_2O_3	Nitrogen trioxide
N_2O_5	Nitrogen pentoxide.

The name of metals is often modified by the ending -ous or -ic. The name of the salt in which the metal has the higher valency has the termination -ic, e.g.

$FeSO_4$	Ferrous sulphate
$Fe_2(SO_4)_3$	Ferric sulphate.

The names of salts of acids ending in -ic are ended with -ate, of acids ending in -ous with -ite, e.g.

Sulphuric acid	(H_2SO_4)	forms sulphates
Sulphurous acid	(H_2SO_3)	forms sulphites.

Substances which may be regarded as derived from water by replacing one of the hydrogen atoms by a metal are called hydroxides. The word hydrate is used for substances that contain water of crystallisation.

An acid is a substance which turns blue litmus red, always contains hydrogen and often gives rise to a salt when it reacts with a metal.

A base, on the other hand, turns red litmus blue and always includes the OH-group. The different kinds of sulphates, sulphites, carbonates, chlorates, etc. are treated in inorganic

chemistry. The vast number of organic substances ridicules description.
Some of the instruments used in a chemical laboratory are test tubes, Bunsen burners, balances, filters, retorts, distillatory apparatus(es), crucibles, etc.

4. Translate into English:

1) Soweit über Hochspannungsanlagen berichtet wird, bezieht sich dies im allgemeinen nur auf Spannungen bis etwa 35kV.
2) Während die meisten Metalle bei steigenden Temperaturen infolge der zunehmenden Wärmebewegung der Atome wachsenden Widerstand zeigen, gibt es auch umgekehrtes Verhalten, z.B. bei Kohle und leitenden Flüssigkeiten.
3) Wie der Widerstand der Metalle mit Erwärmung steigt, so fällt er bei Abkühlung.
4) Sie können mich über dieses Problem konsultieren, sooft Sie es brauchen.
5) Ehe wir uns dieser theoretischen Seite der organischen Chemie zuwenden, wollen wir zuvor eine Reihe grundlegender Arbeitsmethoden kennen lernen, die bei der Untersuchung von organischen Verbindungen zunächst zur Anwendung gelangen müssen, ehe man so schwierige Probleme wie die Frage nach der Zusammenlagerung der Atome in Angriff nehmen kann.

Lesson Sexteen

PLASTICS ENGINEERING

(American)

Plastics, in the modern meaning of the word, are synthetic materials that are capable of being formed into usable products by heating, milling, molding, and similar processes. The term is derived from the Greek plastikos, "to form". In simplest terms, plastics can be described as resins in their molded form. But not all plastics are resins and not all resins can be or necessarily are molded; they can be cast or converted to coatings, self-supporting films, or fibers. Plastics are one of the physical manifestations of resins.

The term plastic is, therefore, essentially a commercial classification to which no strictly scientific definition can be applied. The Society of Plastics Industry has defined plastics as "any one of a large and varied group of materials consisting wholly or in part of combinations of carbon with oxygen, hydrogen, nitrogen, and other organic or inorganic elements which, while solid in the finished state, at some stage in its manufacture is made liquid, and thus capable of being formed into various shapes, most usually through the application, either singly or together, of heat and pressure."

The use of plastics began slowly in the last half of the 19th century following the introduction of celluloid and other cellulose plastics. The invention of Bakelite brought about a marked increase in the use of plastics early in the 20th century. Shortages of natural materials caused by World Wars I and II led to the development of new plastic substitutes. By the 1960s plastics were available in forms that were superior, in certain uses, at least, to leather, paper, glass, metal, wood, rubber, and other natural materials. Plastics were used for a wide variety of purposes; for example, in the manufacture of automobile parts and bodies, toys, television cabinets, clothing, housewares, wall and floor coverings, beverage cases, military body armor, cigarette packages, and furniture.

The modern plastics industry deals chiefly with moldable materials manufactured from organic compounds of high molecular weight, which are known technically as macromolecules or polymers. Chemically, the basic resins consist of combinations of carbon with hydrogen, oxygen, nitrogen, chlorine, fluorine, silicon, and other elements. The resins usually are compounded with plasticizers, stabilizers, fillers, dyes, and pigments to impart properties desired for specific commercial uses and for processing. Rubber is also an organic polymer, but the natural and synthetic rubbers are not included in the modern plastics industry, since the rubber industry was organized and developed before the advent of the synthetic resins.

Based on their behavior toward heat, the plastics used in the molding industry may be divided into two groups: thermoplastic and thermosetting.

The thermoplastic materials are permanently fusible, alternately melting or softening when heated and hardening when cooled. If they are subjected to very high temperatures, vaporization or decomposition takes place. The vinyl, styrene, polyethylene, and cellulosic plastics are examples of this type.

The thermosetting plastics, on the other hand, may be made permanently infusible. This group is usually subdivided into three stages on the basis of changes in physical and chemical properties. The product of the first stage is called the initial condensation product; it may be liquid or solid and is both fusible and soluble. The intermediate product is insoluble and difficult to fuse but can be molded by the proper application of heat and pressure. This is the usual condition of the resin in the molding composition when it is received from the manufacturer. Further heating of this material, as in the process of molding, converts it to the final product, which has a permanent set and maximum hardness, strength, resistivity, and insolubility. The commonly available phenolic, melamine, epoxy, and polyester plastics are examples of thermosetting materials.

THE SYNTHETIC PLASTICS

Public interest has centered on the synthetic resin plastics because of their multiplicity and versatility. The chemist has been able to produce at will resinous materials having the hardness of stone, the transparency of glass, the elasticity of rubber, or the insulating ability of mica. In combination with suitable fillers, these materials are readily molded into products characterized by *strength*, *lightness*, *dimensional stability*, and *resistance to moisture*, *moderate heat*, *sunlight*, and *other deteriorating factors*. They lend themselves especially to the rapid manufacture of large quantities of accurately sized parts by the application of heat and to the use of original or imitative effects in a variety of colors. Among the inexpensive raw materials used in their production are *phenol*, *urea*, *formaldehyde*, *glycerol*, *phthalic anhydride*, *acetylene*, and *petroleum*.

The 10 most widely used plastics are *polyethylene*, the *vinyls*, *styrene resin*, phenolic resin, the *alkyds*, *urea* and *melamine resins*, *coumarone-indene resins*, *polyesters*, *the cellulosics*, and *epoxy resins*.

FOAMED PLASTICS

A rapidly growing market for plastics is found in the production of low density articles that simulate the properties of cork, balsa, and sponges. Synthetic cellular or expanded products are usually made by incorporating gas or gas-producing substances in the plastic mass and by then setting the material in a flexible or rigid expanded state by means of heating, chemical curing, or both. Alternatively, hollow spheres or soluble solids may be introduced and subsequently dissolved from the plastic to leave voids. Open-cell foames (interconnecting voids) are most commonly produced by a mechanical process in which an inert gas (usually carbon dioxide) is mixed directly with the plastic, and the mixture is injected into a mold as foam. The preferred method to obtain a predominantly closed-cell structure uses chemical blowing agents, which at an elevated temperature release a gas (usually nitrogen) causing the plastic mass to expand in the mold or confined space with the formation of myriads of tiny bubbles. The plastic retains its expanded shape upon being cured (vulcanized) or gelled and then cooled to room temperature.

Commercial developments in foamed plastics are centered on the use of polystyrene, polyvinyl chloride, polyurethanes, and polyethylene. Significant markets are thermal and sound insulation for building panels, refrigerating equipment, and pipelines; cushioning materials for furniture and automotive use; buoyant components for life jackets, boat construction, and flotation devices; shock-protective packaging media for missile components, delicate instruments, and fragile articles; and lightweight sandwich structural panels for space vehicles, portable industrial equipment, prefabricated housing, and trailer bodies.

REINFORCED PLASTICS

In preparing low-pressure laminated structures, fibres and fabrics based on glass,asbestos, and synthetic resins are used. Furthermore, the reinforcement is introduced in the form of filaments, mats, and chopped fibers, and high-pressure techniques in matched dies are employed to mold the products. Hence, the term "reinforced plastics" is used to designate high-strength products made both with laminar reinforcements, such as fabrics, paper, or mats, and fibrous reinforcements, such as filaments and chopped fibers. Processes employed in their fabrication include not only hydraulic-press and matched-die methods, but also (1) bag molding, in which a flexible bag or blanket is used to apply pressure against a lay-up while it cures; (2) filament winding, in which continuous strands of glass roving or other fibrous reinforcement are positioned by machine winding on a mandrel of suitable shape and bonded with resin; (3) spray-up, in which a catalyzed resin is projected with continuous or chopped roving onto a mold surface by means of dual-nozzle spray guns; and (4) premix molding, in which chopped fiber, mineral fillers, and viscous resins are blended in a blade-type mixer and molded by compression or transfer methods.

The resins commonly used in reinforced plastics include polyesters, phenolics, and epoxy resins. The primary markets for high-pressure paper and cotton fabric laminates are in electrical insulation, gears, and corrosion-resistant chemical and process-engineering equipment. The fibrous glass-reinforced plastics are used in the construction of boats, aircraft and missile parts, translucent building panels, pipes, tanks, and ducts, truck and trailer bodies and parts, trays, and appliance housings.

OTHER COATING and FORMING TECHNIQES

Fine-particle powders of plastic materials take on fluid characteristics when stirred by a jet of air, a phenomenon that has been utilized to apply plastic materials to metal parts, with subsequent fusion to form a continuous protective film. The process is called fluidized bed coating.

Large molded objects are produced by a method called the Engel process or thermofusion. A plastic powder is introduced into low-cost sheet metal molds, which are placed in an oven to cause the powder adjacent to the walls of the mold to fuse or sinter. After a prescribed time for a given depth of fusion, the excess unfused powder is poured out of the center of the mold, which is then heated further to complete the fusion process.

The space age has challenged the plastics industry to develop new materials suitable for missile nose cones, rocket motor nozzles, and binders for solid propellants. Glazing requirements of aircraft and spacecraft designed to operate at transient temperatures as high as 1 000° F. can be met with composite transparent structures that utilize glass as a heat shield and by monolithic or laminated plastic for inner structural members. In addition, the Echo I satellite balloon demonstrated that films of plastic have an important role in the space program.

Another large-scale use of plastic is in agriculture. Polyethylene film is used to cover cropland in order to conserve moisture and soil, lower labor costs, and increase production. Other growing uses of plastics are found in irrigation, land drainage, protection against erosion, pest control, covers for farm machinery, storage of farm products, and marketing of produce.

In the boatbuilding industry a large proportion of all outboard pleasure boats are made of reinforced plastics. Moreover , 40-foot motor yachts are manufactured of reinforced plastics on a production-line basis, and the United States Navy has used this material for boats up to 50 feet in length.

Air-supported, coated-fabric structures have attracted attention for use as warehouses, factories, and shelters. Plastics are applied in different ways in home construction, including reinforced polyester panels and polyester-faced concrete blocks, acrylic windows and louvers, foamed polystyrene in the roof, and extensive installations of polyvinyl chloride pipe.

Plastics have also made inroads in the manufacture of furniture and in the shoe industry, in which heels, soles, uppers, and other components are often made of plastics. A substantial proportion of all textiles, particularly for industrial applications, are fabricated from man-made fibers. Microporous plastics are expected to produce water-repellent clothing with the breathing qualities of ordinary fabrics.

Many thousands of miles of plastic pipe made from polyethylene, polyvinyl chloride, and acrylonitrile-butadiene-styrene (ABS) pipe are in operation, carrying such diverse products as natural gas, crude oil, fruit juices, laundry cleaning compounds, battery acids, sewage wastes, various types of chemicals, and potable, irrigation, and salt water. Millions of pounds of vinyl resin and polystyrene are used annually to produce high-fidelity records.

Medical uses of plastics include hospital equipment and a variety of replacements for eyes, ears, limbs, and internal organs in the human body. Plastic heart valves have been implanted in thousands of persons, and plastic arteries have become well-established surgical reconstructions.

RECYCLED PLASTICS

Responding generally to the environmental protection movement and to the growing shortage of petrochemicals from which most plastics and polymers are manufactured, a trend toward recycling of discarded plastics picked up momentum in 1976. Plastic wastes are pyrolyzed or broken down at high temperatures in an inert atmosphere into useful hydrocarbons and other products. Depending on the plastic starting material and the temperature at which it is pyrolyzed, the reaction products can vary widely. For example, when polyethylene is heated to 740° C (1,365° F), it yields about 25 % ethylene, by weight, 16 % methane, 12 % benzene, 10 % propylene, and small amounts of carbon, hydrogen, and other products. Heating polyvinyl chloride produces about 56 % hydrochloric acid, 2 % ethylene, 22 % assorted aromatics, and a collection of other products. An old rubber tire subjected to the same conditions yields about 43 % carbon, 10 % methane, 18 % aromatics, and smaller amounts of unsaturated and saturated hydrocarbons. Plastic wastes, if recycled efficiently, should relieve some of the strain on world oil resources and help solve an environmental problem by eliminating the vast amounts of plastic wastes accumulating upon the Earth.

QUESTIONS

1) Which articles are made of plastics ?
2) What can be said about the properties of plastics ?
3) Which reinforcing agents are used ?
4) How can plastics be described in simplest terms ?
5) Which resins are plastics based on ?
6) What does the modern plastics industry deal with ?
7) Why has public interest centered on the synthetic resin plastics ?
8) What do we call the ten most widely used plastics ?
9) Which are the two groups of plastics used in the molding industry ?
10) Which are the major features of foamed plastics ?
11) What does the term "reinforced plastics" mean ?
12) How has the space age challenged the plastics industry ?
13) What do you know about recycled plastics ?
14) What problems remain to be solved by the plastics industry ?

IMPORTANT TERMS

armor (US), armour (Br)	- Panzer m, Panzerung f, Armierung f,
balsa	- Balsaholz n, westindisches Korkholz, Flossbaumholz n
behavior (US), behaviour(Br)	- Verhalten n
beverage case	- Kiste f für Getränke, Harass m
body	- Körper m; Karosserie f
cast, to	- giessen, vergiessen
coating	- Ueberzug m, Belag m; Beschichtung f, Oberflächenimprägnierung f
construction industry	- Baugewerbe n, Bauindustrie f
cure, to	- härten, aushärten

deteriorate, to	- (sich) verschlechtern
fiber (US), fibre (Br)	- Faser f
filler	- Abfüllmaschine f; Füllmasse f, Füllstoff m; Harzträger m, Porenfüller m, Streckmittel n
floor sheet covering	- Fussbodenbelag m
fluidization	- Staubfliessverfahren n, Wirbelschichtverfahren n
glass fiber reinforced polyester resin (g.r.p.)	- glasfaserverstärktes Polyesterharz (GUP)
houseware (US)	- Haushaltwaren f/pl
infusible	- unschmelzbar
melamine resin ('meləmi:N)	- Melaminharz n
mica ('maikə)	- Glimmer m
milling	- Mahlen n, Zerkleinern n
moisture ('mɔistʃə)	- Feuchtigkeit f
mold, to (US), mould, to (Br)	- formen, gestalten; giessen, pressen
mold (US), mould (Br)	- Form f, Pressform f, Presswerkzeug n; Bütte f; Modell n; Schablone f
molding (US), moulding (Br)	- Formen n; Formpressen n, Pressverfahren n; Pressteil n, Pressling m, Formling m
plastic	- Kunststoff m, Plast m, Plastik n (auch f), Plastikstoff m; Pressstoff m, Kunstharz n
plastic (adj.)	- plastisch, bildsam; (ver)formbar, geschmeidig; aus Kunststoff od. Plastik
plasticity	- Verformbarkeit f, Formbarkeit f, Plastizität f, Bildsamkeit f, Geschmeidigkeit f
plasticize, to ('plæsti,saiz)	- erweichen, weich machen, plasti(fi)zieren
plasticizer	- Weichmacher m, Plasti(fi)kator m, Plastizierer m, Plastifiziermittel n
plastics (pl)	- Kunststoffe m/pl, Plaste m/pl, Plastiks n/pl, auch: Plastiken f/pl
plastify, to	- plastifizieren, weich machen, erweichen
plastifying agent	- Plasti(fi)kator m, Plastizierer m, Plastifiziermittel n, Weichmacher m
protective site clothing	- Arbeitsschutzbekleidung f für Baustelle
recycling	- Wiederverwendung f, Wiederverwertung f, Rückführung f

reinforce, to (ˌriːinˈfɔːs)	- verstärken
reinforced plastics	- verstärkte Kunststoffe m/pl
reinforcing agent	- Füllmittel n
resin (ˈrezin)	- Harz n, Kunstharz n
roofing sheet	- Dachdeckungsplatte f
sandwich structure	- Verbundbauteil n aus fester Aussenhaut und leichtem Stützstoff in Innern
sanitary fitting	- sanitäres Formstück
solubility	- Löslichkeit f, Lösbarkeit f
soluble	- löslich (Stoff); lösbar (Problem)
television cabinet	- Gehäuse n für Fernsehgerät
thermosetting plastics	- hitzehärtbare Kunststoffe m/pl, Duroplaste m/pl
wall panelling	- (Leicht-) Wandelement n
waste	- Abfall m, Abfallprodukt n; Müll m
water-repellent	- wasserabstossend, wasserabweisend

GRAMMAR and NOTES

1. Gewisse Adjektive auf -able, -ible sowie meist auch present (anwesend) können nach Superlativen und ihnen bedeutungsnahen Wörtern wie all und only hinter das Substantiv treten: the greatest difficulty imaginable - die denkbar grösste Schwierigkeit; it is the only book available - es ist das einzige zur Verfügung stehende Buch.

Das gleiche gilt für das sonst nur prädikative alive und known: the only instances known - die einzigen bekannten Beispiele; the greatest scientist alive - der grösste lebende Wissenschaftler.

In einschränkender Bedeutung (="eigentlich, im engeren Sinne") wird gewöhnlich proper nachgestellt: architecture proper - die eigentliche Architektur.

Last, next und past können auch nachgestellt werden: on Tuesday next (= next Tuesday) - (am) nächsten Dienstag.

In einer Reihe von Titeln (a) und erstarrten Ausdrücken (b), die dem

Französischen od. Lateinischen nachgebildet wurden, finden sich nachgestellte Adjektive, z.B.:

a) ambassador plenipotentiary - bevollmächtigter Botschafter
consulate general - Generalkonsulat n
secretary - general (of the United Nations) - Generalsekretär (der Vereinten Nationen)
sonst: general secretary (of trade union, etc.) - Generalsekretär (der Gewerkschaften usw.)

b) Goodness gracious! - Du liebe Güte!
from time immemorial - seit undenklicher Zeit

2. Im amerikanischen Englisch wird der Konjunktiv mehr als im brit. Englisch verwendet. In Nebensätzen ist es besonders nach Verben, die eine Aufforderung, einen Befehl, einen Antrag u.dgl. ausdrücken, z.B.: ask, demand, request, require, suggest, insist, propose, recommend. Weiter verwendet man den Konjunktiv nach unpersönlichen Ausdrücken wie z.B.:

It is necessary - Es ist notwendig, nötig, erforderlich
It is imperative - Es ist unbedingt erforderlich
It is essential - Es ist wesentlich, wichtig, erforderlich
It is advisable - Es ist ratsam
It is desirable - Es ist wünschenswert
It is a rule - In der Regel, normalerweise, wie gewöhnlich

Beispiele: It was proposed that the case be re-examined.
It is imperative that you be here.

Im britischen Englisch wird eine Umschreibung mit should angewandt:
It was proposed that the case should be re-examined.

EXERCISES

1. Translate into German: attainable, undeniable, unexcusable, reversible, unaccountable, audible, visible, intelligible, unacceptable, unachievable.
2. What are the opposits? to increase, to add, interior, thermoplastic, metal, cheap, early, everything, light (weight), past, quick little, high.

3. Read and Translate into German:

a) The results correspond closely. The street was closed to motor traffic. He acted on legal advice. On closer examination, several mistakes were discovered. There was close resemblance between the two cases. He has no excuse for lagging behind the plan. It is necessary to observe the safety rules when working with a live conductor. This room does not seem to be lived in. The present volume is the second part of a series. He made a record of the observation. That deviation is worth recording. Directions for use.

b) Negligible, reproducible, measurable, obtainable; major-general, air vice marshal, consul-general, lieutenant-general, inspector-general, Chief of Defence Staff, Chief of the Joint Chiefs of Staff (U.S.), the Postmaster-General, Poet Laureate.

4. Translate into English: Die mechanische Bedeutung von PVC ist so gross, dass sich von diesem Standpunkt aus eine viel ausführlichere Beschreibung rechtfertigen würde. Es ist wünschenswert, dass Sie die Analyse noch heute machen. Es ist ratsam, dass er die Kontrolle der Daten gleich durchführt. Es ist unmöglich, an dieser Stelle auf all die untersuchten Einzelprobleme einzugehen. Es sei hier auf die diesbezüglichen Normen verwiesen.

ATOMIC ENERGY

Not a single advance in the history of world science and engineering has given mankind a lever for progress that can be compared with the release of the potential energy of the atomic nucleus or the use of the colossal energy in man-made thermonuclear transformation.

Nuclear power opens up completely new technical and economic potentialities.

One of the ways of utilizing nuclear fuel is the production of electric energy in atomic power plants.

Atomic energy, however, has many other peaceful uses. Just think of the revolutionizing effect the colossal power of nuclear fuel will have on means of transportation! Or the new processes that will become applicable in inorganic chemistry and the technology of high-temperature transformations! Or the new potentialities in mining and in penetrating into the depth of the earth's crust!

The vistas in the peaceful use of the thermo-nuclear transformations are broad indeed. The hydrogen in water as a source of fuel. Fuel billions of times more concentrated than coal. Thermonuclear reactions used for building, and for increasing the riches and happiness of the entire population of the globe, for elevating man to new heights in his power over Nature. An attractive and inspiring goal, one well worthy of the close knit, combined effort of all nations.

We stand on the threshold of a great scientific, technical, and industrial revolution. We have already entered the atomic age, we are living and working in it. This age brings with it a revolution of the old technical values; at every step it is full of new and as yet often little-used possibilities.

The atomic industry supplies science and engineering with radioactive elements whose radiations are employed in medicine, hygiene, the food industry, fault detection, automatic control, geological prospecting, and many other fields.

NUCLEAR PHYSICS

Fundamental Particles and Rays

Modern physics has discovered a complicated array of fundamental particles of which all matter is composed. These particles are to a variable extent present in the devices used in modern nuclear technology. Each produces biological effects; each has its own characteristic penetration properties. To these particles we must add electromagnetic radiation, usually called gamma rays or X-rays, the photons, quanta, or units of which can also produce biological effects.

The word "ray" or "radiation" is used to mean a beam of wave-type radiation, as in a ray of light or X-ray, and also a stream of particles, as in cathode rays or alpha rays. Often when a ray of any kind strikes an atom or molecule, regardless of whether or not this atom is part of a biological system, it may knock an electron out of the atom. The process of knocking charged fragments out of previously neutral atoms or molecules is called ionization.

It is by measuring the amount of ionization that radiation is most usually detected or identified. The most usual detecting devices are the Geiger counter, proportional counters, and ionization chambers, Wilson cloud chambers, and photographic emulsions. In the Geiger counter, the ionization initiates a discharge for each ionizing event that takes place in the counter. For example, the passage of a particle through the counter, if the particle produces ionization, is such an ionizing event. In the proportional counters and ionization chambers, the ions produced are collected and measured directly. In the Wilson chamber, the condensation of vapour along the tracks of ionizing particles leaves cloud trails, which like the vapour trails of airplanes, can be photographed. In photographic emulsions, ionizing events themselves leave developable tracks, and the actual trail of a particle can be seen. Thus emulsions are like continuously-sensitive cloud chambers. Emulsions are small, light, easily transportable, and will accumulate all the radiation they receive until development.

ATOMIC STRUCTURE

All elementary forms of matter are composed of very small unit quantities called atoms. The atoms of a given element all have the same size and weight. The atoms of different elements have different sizes and weights. Atoms of the same or different elements unite with each other to form very small unit quantities of compound substances called molecules.

Atoms are composed of a positively charged central core or nucleus, surrounded by a cloud of negatively charged electrons. The charges are equal, so that the atom is electrically neutral. Atoms form chemical elements, as hydrogen, iron, or lead. Two or more atoms sticking together form a molecule. Molecules form chemical compounds.

Nucleus is the central part of the atom, which makes up most of the weight of the atom and is charged with positive electricity. Atomic nuclei are, it is now believed, made up of two kinds of fundamental particles, protons and neutrons.

The total number of particles of both kinds in the nucleus is given by the rough atomic weight. The number of protons is given by the atomic number. The number of neutrons can thus be found by subtracting the atomic number from the atomic weight.

Proton is a small particle with a positive electric charge equal numerically to the negative electric charge of the electron, 1.60×10^{-19} coulomb. A single proton makes up the entire nucleus of the ordinary hydrogen atom. The nuclei of atoms of other substances contain a number of protons given by the atomic number of the element.

Neutron is a particle with no electric charge, but with a mass approximately the same as that of the proton, about 1.67×10^{-24} g. In nature, neutrons are locked up in the nucleus of an atom, but they can be knocked out in various kinds of atom-smashing

experiments.
The neutrons, because of their lack of charge, readily penetrate other nuclei. The new nucleus thus formed is sometimes stable, but often unstable. These unstable nuclei decompose spontaneously and may emit protons or neutrons, or clusters of two protons and two neutrons, called alpha particles. They may emit electrons, a process called beta decay; or they may radiate gamma rays, or occasionally several of the above in succession.

Electron is the smallest known particle having a negative electric charge. The part of an atom outside the nucleus is made of electrons, the number of which, being equal to the protons in the nucleus, is the same as the atomic number of the atoms. An electric current in a wire consists of the motion of electrons through the material of the wire. In radio tubes and in cathode-ray television tubes, the current is carried by a stream of electrons. The beta particles emitted by certain radioactive materials are high-speed electrons.
The nucleus contains most of the mass of the atom. The electron weight is only about one two-thousandth part of the total. The number of protons in the nucleus determines what chemical elements the nucleus represents and is called the atomic number of the element, which varies between 1 (hydrogen) and 92 (uranium). The number of protons plus neutrons determines the atomic weight which varies between 1 (hydrogen) and 238 (uranium) for the naturally- occurring elements. Atoms may have the same number of protons and a different number of neutrons, in which case they are atoms of the same element but of different weights. Such differing atoms are called isotopes.
For an atom in its normal state the number of protons in the nucleus is equal to the number of electrons revolving around it, and the atom as a whole displays no electric charge. A few electrons may readily be removed from, or added to, an atom leaving it with surplus of positive or negative charge.

Atomic Weight.- This term is used to denote the weight of any atom as measured on an arbitrary scale based on the weight of an oxygen atom. On this scale the figure 16 is chosen as the weight of the oxygen atom. Adopting this convention, it is found that the weights of atoms of the other elements can be expressed very nearly as whole numbers. These whole numbers are called the rough atomic weights. The atomic weight of ordinary hydrogen is 1; that is, a hydrogen atom is roughly one-sixteenth as heavy as an oxygen atom. The atomic weight of heavy hydrogen is 2; helium 4; lithium atoms occur in two varieties, with weights 6 and 7. The figure giving the rough weight of an atom on this scale is also the total number of protons and neutrons contained in the nucleus of the atom.

The precise atomic weights differ somewhat from these whole numbers by approximately one-thousandth of the total weight. This difference, however, is of decisive importance for estimating the energy released on the formation of these atoms in accordance with the mass-energy equivalence relation.

Mass Number.- This is another term for the rough atomic weight; approximately the weight of the nucleus. It tells the total number of protons and neutrons in the nucleus. It should not be confused with atomic number, which gives at once the number of protons in the nucleus and the number of electrons outside the nucleus.

ISOTOPES

One of the most widely publicized aspects of work on atomic energy is the use of radioisotopes. The nucleus of an atom is built up of protons and neutrons. In all the atoms of a given element, the number of protons in the nucleus is constant; it is called the atomic number and it determines the chemical properties of the atom. With this fixed number of protons there may be associated a varying number of neutrons. This means that all the atoms of any particular element have the same chemical properties, but their masses may differ (because the mass of an atom is equal, approximately, to the sum of the masses of the protons and neutrons in the nucleus). These different forms of the same element are known as isotopes of the element. The isotopes of one element differ from one another in their physical, not their chemical, properties. Some isotopes are stable; the differences between them are solely those arising from the difference in mass, for example, different amounts of bending in a magnetic field, different rates of diffusion, etc. Other isotopes are radioactive, that is their nuclei break down spontaneously and emit particles or electromagnetic waves, or both; radioactive isotopes differ from one another in, for example, the type and energy of the particles they emit, and in their half lives. At least one radioactive isotope is known to exist for all known elements. The two features of radioactive isotopes that give them their technological importance are that they are indistinguishable in their chemical properties from the stable isotopes of the same element, and that they emit radiation which can be detected by various means, such as photographic films, electronic instruments like Geiger-Müller counter, and the scintillations produced in certain phosphors and organic crystals. In this way they can be detected in the presence of considerably larger quantities of stable atoms of the same element, by methods which ordinarily do not require any interference with the substance in which the atoms are embedded. Stable isotopes, on the other hand, differ from one another only in the masses of their atoms; the presence of a small quantity of one isotope among a large mass of another can be determined by instruments like the mass spectrometer, but the process is somewhat complicated and requires that the specimen should be obtained in a form suitable to the instrument.

QUESTIONS

1) What do we mean by modern physics?
2) What do we call gamma rays or X-rays?
3) What do we mean by "radiation"?
4) What is called ionization?
5) By means of what is radiation most usually detected?
6) What are the most usual detecting devices?
7) What do we understand by atomic structure?
8) What is a nucleus?
9) What do we mean by "rough atomic weight"?
10) How can be found the number of neutrons?
11) What is a proton? a neutron? an electron?
12) What do we call "beta decay"?
13) What is an isotope?
14) What is the atomic weight of oxygen?
15) What is the "mass number"?
16) What is the half life of a radioactive substance?

IMPORTANT TERMS

array	-	Anordnung f, Schema n, Tafel f
atom smasher	-	Atomzertrümmerer m, Atomauflöser m
atom smashing	-	Atomzertrümmerung f
atomic power plant	-	Atomkraftwerk n
atomic power station	-	Atomkraftwerk n
automatic control	-	automatische Steuerung, Selbststeuerung f
beam	-	Strahl m, Strahlenbündel n; Balken m, Träger m (Bauwesen); (text) Kettbaum m
beta decay ('bi:tə di'kei)	-	Beta-Zerfall m, Beta-Umwandlung f
cathode ray	-	Katodenstrahl m, Elektronenstrahl m, Elektronenstrahlbündel n
cathode-ray television tube	-	Katodenstrahlfernsehröhre f

charged particle	geladenes Teilchen
cloud trails	Nebelspuren f/pl (Wilsonkammer)
cluster	Büschel n; Anhäufung f, Häufung f
cluster of atoms	Atomhaufen m
cluster structure	(phys) Büschelstruktur f
continuously-sensitive cloud chamber	kontinuierliche Nebelkammer
developable	abwickelbar
discharge	(el) Entladung f; Entladen n (Fracht); Löschen n (Schiffsfracht); Entleeren n (Waggons); Ablassen n, Ausströmen n, Ausfliessen n (Gase, Flüssigkeiten)
earth's crust	Erdkruste f
embedded in	eingebettet in, eingelagert in, eingelassen in, gekapselt in
emulsion (iˈmʌlʃən)	Emulsion f
fault detection	Fehlersuche f
fault detector	Fehlersuchgerät n
food industry	Nahrungsmittelindustrie f
gamma ray	Gamma-Strahl m
Geiger-Müller counter (tube)	Geiger-Müller-Zähler m, Geiger-Müller Zählrohr n, GM-Zählrohr n
half life	Halbwertzeit f
half-life period	Halbwertzeit f
high-speed electron	schnelles Elektron
interference	Interferenz f, Ueberlagerung f (einer Störung); Störung f; Behinderung f; Beeinflussung f; Abmass n, Uebermass n
ionization (ˌaiənaiˈzeiʃən)	Jonisation f, Jonisierung f
ionization chamber	Jonisationskammer f
knit (nit)	Verknüpfung f, Verbindung f, Zusammenfügen n

knock out, to - ausstossen, herausschiessen (Teilchen)
mass-energy equivalence - Masse(n)-Energie-Aequivalenz f
mass spectrometer - Massenspektrometer n
mining - Bergbau m, Abbau m, Ausbeutung f, Gewinnung f
neutron ('nju:trɔn) - Neutron n
nuclear fuel - Kernbrennstoff m; Spaltstoff m
nucleus, pl.-clei ('nju:kliəs,-ai) - Kern m (Atom); Keim m (Kristall)
  nucleus of an atom - Atomkern m
penetration - Durchdringung f, Durchdringen n, Eindringen n; Durchgriff m (der Anodenspannung); (metall) Eindringtiefe f
proportional counter (tube) - Proportionalzählrohr n, Proportionalzähler m
prospecting - Suche f, Aufsuchen n, Prospektieren n; Schürfen n, Schürfung f; Muten n, Mutung f
proton ('prəutɔn) - Proton n
quantum, pl.-ta ('kwɔntəm,-tə) - Quantum n, Menge f; (phys) Quant n, Teilchen n, Strahl m
quantum chemistry - Quantenchemie f
quantum electrodynamics - Quantenelektrodynamik f
scintillation - Flimmern n, Funkeln n, Szintillation f; Funken n, Sprühfunkenbildung f
stick together, to - zusammenkleben (Kontakte usw.)
surplus ('sə:pləs) - Ueberschuss m; Mehrwert m
thermonuclear reaction - thermonukleare Reaktion
threshold ('θreʃhəuld) - Schwelle f; Türschwelle f; Energieschwelle f, Schwellenwert m der Energie
vista ('vistə) - Aussicht f, Blick m
Wilson chamber - Wilson-Kammer f, (Wilsonsche) Nebelkammer f

GRAMMAR and NOTES

1. The process of knocking charged fragments out of previously neutral atoms or molecules is called ionization.
   It is by measuring the amount of ionization that radiation is most usually detected or identified.

   Das Gerundium als Satzglied kann in vielen Fällen verwendet werden, oft aber ist das Gerundium (bzw. Verbalsubstantiv) die einzig mögliche Verbalform.

   Das Gerundium steht

   a) als Subjekt des Satzes:
   Measuring the speed of this machine required special devices.
   Die Messung der Drehzahl dieser Maschine erforderte Spezialgeräte. Um die Drehzahl der Maschine zu messen, waren Spezialgeräte nötig.

   b) nach unabhängigen Präpositionen:
   The accumulator is charged by passing a current through it.
   Der Akkumulator wird geladen, indem man Strom hindurchschickt.
   Der Akkumulator wird durch Hindurchschicken eines Stromes geladen.

   c) nach Verb + Präposition:
   They succeeded in solving the problem.
   Es gelang ihnen, die Aufgabe zu lösen.

   d) nach Adjektiv + Präposition:
   An electric current is capable of decomposing water.
   Ein elektrischer Strom ist imstande, Wasser zu zersetzen.

   e) nach Substantiv + Präposition:
   The mechanical rectifiers all have the disadvantage of having moving parts.
   Die mechanischen Gleichrichter haben alle den Nachteil, dass sie sich bewegende Teile besitzen.

f) Verb + Gerundium als direktes Objekt:
They stopped working an hour ago.
Sie hörten vor einer Stunde zu arbeiten auf.

g) Das Gerundium mit eigenem Subjekt:
Sind im Haupt- und Nebensatz verschiedene Handlungsträger vorhanden, so steht das Subjekt des Nebensatzes vor dem Gerundium.

We know of him working at a research institute.
oder
We know of his working at a research institute.

Wir wissen, dass er in einem Forschungsinstitut arbeitet.

2. Word Study

penetrability	- Durchdringbarkeit f, Durchlässigkeit f
penetrant material	- Eindringmedium n (Werkstoffprüfung)
penetrate, to	- durchdringen, eindringen, einsickern; (durch)tränken, imprägnieren
penetrating	- hart, energiereich (Strahlung)
penetrating particle	- energiereiches Teilchen
penetrating radiation	- durchdringende (harte) Strahlung; Durchstrahlung f
penetration	- Durchdringung f, Durchdringen n
penetration of rays	- Durchdringung f von Strahlen
penetrative	- durchdringend, Durchdringungs...,
penetrative power	- Durchdringungsvermögen n
penetrativeness	- Durchdringungsvermögen n
penetrator	- Eindringkörper m (Härteprüfung)
penetrometer	- Eindruck(tiefen)messer m, Eindringgerät n (Werkstoffprüfung)

By penetrability is understood the susceptibility of an object to be penetrated by radiation.
Penetrator is a tool used to test hardness.
Penetrometer is an instrument for measuring the hardness of X-rays.

EXERCISES

1. Transform the following sentences:
Example:

a) It is often better to drive slowly.

b) Driving slowly is often better.

It was easy for the properly trained technician to locate the fault in the apparatus. It was not so difficult to understand the electronic view finder. It is not practicable to design a fuse which will break a circuit on a very small overload. To build up a magnetic field requires a certain amount of energy. To carry out this complicated work requires special knowledge in this field of science.

2. Connect the following sentences:
Example:

a) We can change alternating current into direct current (use a rectifying tube).

b) We can change alternating current into direct current by using a rectifying tube.

These problems can be overcome (improve the design). The mistake can be found (go through all the steps of the procedure). It is possible to take perfectly stable nuclei and make them unstable (shoot into them various particles with the proper amount of energy. The capacity of this cell can be increased (connect a number of negative plates and a number of positive plates in parallel).

3. Translate into German:

We know of your having achieved good results. The investigations concerned the possibility of the cathode rays detected being charged particles. A great number of tests were carried out without any unanticipated breakdowns occurring. Our students have already finished studying the initial data. Nowadays engineers prefer using semiconductors for generating heat and cold. The engineers intended applying a new method of welding. Atomic energy can supply power for lighting cities. Telemetry is the technique of making remote measurements and observations. Two basic methods are available for measuring the capacitance of a capacitor. This scientist has devoted many years to carrying out research into the properties of these materials.

4. Translate into English:

1) Fremdsprachen effektiv zu lernen erfordert viel Geduld.
2) Durch Erhitzen einer Substanz können wir ihre Temperatur bis auf den Siedepunkt erhöhen.
3) Beim Arbeiten mit radioaktiven Isotopen ist Vorischt nötig.
4) Es ist eine gute Regel, die Motortemperatur bis beinahe auf normal steigen zu lassen, bevor man volle Motorleistung verlangt.
5) Eine Methode, um zu verhindern, dass sich Muttern lösen, besteht darin, dass man Federringe anbringt.
6) Dieser Motor benötigt alle drei Monate, der neueste alle fünf Monate eine Durchsicht.
7) Die Atomenergie kann Strom für die Beleuchtung von Städten liefern.

Lesson Eighteen

RADIOACTIVITY

Radioactive Substances.- In 1896, it was found that compounds of uranium emitted rays that gave an impression on a photographic plate covered with black paper. They were able to pass through thin sheets of metal and other substances that are opaque to light. They also possess the important property of discharging a body that is electrified, either positively or negatively. This property of discharging an electrified body is found to be due to the fact that these rays produce ions in the gas through which they pass.

It was soon found that this property of emitting penetrating radiations is not confined to uranium and its compounds. Thorium and its compounds and minerals containing thorium have this same property. Such substances are said to be radioactive.

By studying radioactive minerals which contained uranium and thorium,the Curies found that these minerals often contain a substance which is much more radioactive than either uranium or thorium. This element was finally isolated and called radium. It is derived chiefly from pitchblende and in the pure state possesses the property of radioactivity in an astonishing degree. In order to obtain a few decigrams of radium, it is necessary to start with several tons of pitchblende.

Nature of the Radiations.- Radioactivity is the spontaneous disintegration of certain heavy elements (radium, uranium and others) accompanied by the emission of high-energy radiation which consists of three kinds of rays: alpha-rays, beta-rays, and gamma-rays. The ultimate end product of radioactive disintegration is one of the isotopes of lead. The radiation can be split up into its three components by passing it through a magnetic field.

Alpha-rays consist of alpha-particles, which are the nuclei of helium atoms which are positively charged on account of having lost two electrons.

Beta-rays consist of beta-particles, which are electrons (negatively charged elementary particles). The positively charged alpha-particles and the negatively charged beta-particles are deflected in opposite directions by the magnetic field.

Gamma-rays are an electromagnetic radiation of very short wavelength and high penetrating power (about 10^{-12}cm); they are not deflected by the magnetic field. All three kinds of radiation cause blackening of a photographic plate and ionisation of gases, so that they can be detected by photographic or electric methods.

In addition to the natural radioactivity of radium and uranium there is artificially induced radioactivity, by which is understood a state of radioactivity induced in normally non-radioactive elements by means of artificial atomic transmutation. Such elements are now obtained as waste products from nuclear reactors. All radioactive phenomena die away after a certain length of time. The so-called half-life (or half-decay period) has been introduced as a criterion of this. It denotes the period in which the activity of a radioactive substance falls to half its original value. It varies considerably for different substances and ranges from a vast number of years to a tiny fraction of a second. The half-lives of the radioactive fission products of a nuclear explosion are mainly in the range of 10-60 days, but there are also much longer-lasting products such as strontium 90 and caesium 137, which have half-lives of about 30 years.

Detection and Measurement of Nuclear Radiations.

One of the properties common to nearly all nuclear radiations and particles is their ability to ionize - that is, to remove electrons from atoms of the material through which they pass. This process is the basis of most of the instruments employed for the detection and measurement of nuclear radiations. Those most commonly used are ionization chambers, proportional counters and Geiger-Müller counters. All three devices have the same basic design — an enclosure filled with a mixture of gases or vapours, containing two electrodes connected to a power supply. The particle or quantum entering the instrument produces by ionization a small group of electrons and positive ions, which are separated by the electric field, electrons moving quickly to the positive electrode or collector, and positive ions more slowly (because of their greater mass) to the opposite side. The change in potential at the collector is amplified and passed to a suitable recording device.

Cloud - Chamber Method of Observing Collisions.

A number of ingenious methods have been devised for observing atomic collisions. One of the most important of them is the cloud-chamber method, by means of which the tracks of the colliding particles are photographed before and after the collision. If a rapid expansion takes place in a vessel containing saturated water vapour, a fog is formed, provided that there are nuclei about which the water vapour can condense. When swiftly moving electrified particles pass through such a vessel, ions are produced along the tracks of the particles. These ions serve as centres about which the water vapour can condense when a suitable expansion takes place in the chamber. The fog that is thus produced by the expansion is confined to these tracks and serves to locate the path of the moving electrified particle. By photographing these tracks, the behaviour of the particles before and after collision can be studied.

Fission and Chain Reaction.

When a neutron moving with the right velocity strikes the isotope of uranium having an atomic weight of 235, the uranium atom breaks into medium-sized atoms whose total masses are very slightly less than the mass of the original uranium atom. This difference in mass reappears as energy according to the principle of Einstein, which shows the equivalence of mass and energy. This type of nuclear disintegration is called nuclear fission. It has been observed in other heavy radioactive elements. The atomic nuclei produced in a fission process may be identified by chemical or physical methods. Secondary neutrons are also produced in these fission processes. If these secondary neutrons have suitable velocities, they may produce further fission in the neighbouring uranium atoms. There is thus set up a chain reaction in which neutrons produced in one fission process may produce additional fissions. If the neutrons have suitable velocities, this chain reaction will continue until all the uranium atoms are used up. The amount of energy released in such a reaction is very large.

Fission can be induced by bombardment with other particles, such as protons, deutrons and α-particles, and with β-ray quanta, if enough energy is added to the target nucleus. Elements lighter than uranium can be made to undergo fission by exposure to projectiles of high energy.

PARTICLE ACCELERATORS

Atoms are so small that all our knowledge of their structure and behaviour must be obtained indirectly. The electrons which are responsible for most of the chemical and physical properties of an element are easily displaced or detached and a good deal of information about the outer parts of the atom can be collected by moderately simple techniques. Study of the nucleus is more difficult, for the particles comprising it are very firmly bound together and only the most vigorous disturbance will separate them. A common — and fruitful — method of investigation is the exposure of suitable targets to bombardment with high - energy particles or radiations, and a variety of particle accelerators have been devised for this purpose during the last years.

CYCLOTRONS, BETATRONS, SYNCHROTRONS

The acceleration is usually produced by causing the particles to travel in circular paths, and for this reason the various machines used for the purpose are known collectively as "circular accelerators".

The cyclotron.- According to the conventional theory of electrodynamics, the rotational frequency of an electrically charged particle travelling in a circular orbit in a magnetic field is independent of the radius of its orbit. The energy of the particle increases with its velocity. The operation of the cyclotron is based on these principles. The evacuated acceleration chamber is mounted in a homogeneous magnetic field between the poles of a powerful electromagnet. Ions (electrically charged atoms) are produced by a source at the centre of the chamber and are forced to travel along circular orbits by the magnetic field. As their circular frequency is constant, the ions can be accelerated by means of a high-frequency alternating electric field of the same frequency. This is done with the aid of two hollow semicircular electrodes (called "dees") to which a high-frequency oscillating voltage is applied. Each time an ion passes from one dee into the other, it is accelerated by the electric field that exists in the gap between the two dees. This does not cause any change in the rotational frequency, but it does increase the velocity of the ion, with the result that the radius of its orbit increases. The ion thus progressively acquires more and more energy and moves into orbits of increasingly large radius, i.e., it moves in a spiral path, until it is finally deflected out of the vacuum chamber at the periphery.

The synchrotron.-Whereas the cyclotron is used for the acceleration of particles in the low velocity range, the synchrotron is an accelerator for particles with velocities approaching the velocity of light. The operating principle of the two machines is, however, very similar. As distinct from what happens in the cyclotron, in the synchrotron both the orbit radius of the particle and the rotational frequency remain constant, whereas the magnetic field increases (just as in betatron). The fact that the energy of the particles increases despite the fact that their velocity remains nearly constant is something that can be explained only with the aid of the relativity theory: when the particle velocity becomes almost equal to the velocity of light, even a small increase in velocity will result in a considerable increase in the mass of the particle. The gain in energy achieved in the synchrotron is therefore due, not to a velocity increase, but to an increase in mass.

__The betatron__ resembles a transformer in its general construction: an iron core is provided with an exciting winding through which an alternating current flows. Instead of a secondary winding, however, the betatron has an evacuated annular tube into which electrons are shot. In consequence of magnetic induction, an annular alternating electric field (rotational field) is produced in the tube. This field, whose direction is perpendicular to that of the magnetic field, can have a retarding as well as an accelerating effect on the electrons. Since acceleration is required, an intermittent mode of operation is applied. The electrons are shot into the annular tube at the instant when the alternating electric field attains its maximum strength. During the next quarter period of the alternating field strength the electrons are accelerated by the field,while the field strength continuously decreases. The electrons must be removed from the annular tube not later than the end of this quarter period, for otherwise they would be decelerated in the following half period.

QUESTIONS

1) Can mass change into radiation?
2) Are alpha-particles helium nuclei?
3) What is artificial radioactivity?
4) How many types of radiations are emitted by radioactive substances?
5) What is meant by "chain reaction"?
6) By means of what can fission be induced?
7) What do we call "particle accelerators?
8) What do scientists engaged in research into the structure of the atom use for bombarding the atom?
9) By what means is the acceleration of elementary particles usually produced?
10) What do we understand by "circular accelerators"?

IMPORTANT TERMS

acceleration chamber	-	Beschleunigungskammer f
blackening	-	Schwärzung f(Fototechnik)
by-product	-	Nebenprodukt n; Abfallerzeugnis n, Abfallprodukt n (verwertbares)
caesium (ˈsiːzjəm)	-	Zäsium n
chain reaction	-	Kettenreaktion f
criterion, pl.-ria (krai'ti(ə)riən,-ə)	-	Kriterium n, Kennzeichen n
deuteron ('dju:tə,rɔn)	-	Deuteron n, Deuton n
devise, to	-	ausdenken, erdenken, erfinden, ersinnen
die away, to	-	nachlassen, abflauen; abklingen, auf Null abnehmen
exciting winding	-	Erregerwicklung f
fissile material	-	Spaltmaterial n, spaltbares Material
fission	-	Kernspaltung f
fission product	-	Spaltprodukt n
fission product of uranium	-	Uranspaltprodukt n
fission product refining plant	-	Aufarbeitungsanlage f für Spaltprodukte
fission reactor	-	Spaltungsreaktor m
fission yield	-	Spalt(produkt)ausbeute f
heavy-element chemistry	-	Chemie f der schweren Elemente
high-energy physics	-	Physik f hoher Energien
high-energy radiation	-	energiereiche (harte) Strahlung
intermittent	-	diskontinuierlich, intermittierend, zeitweilig aussetzend; periodisch, zyklisch; absatzweise, stossweise; unterbrochen
iron core	-	Eisenkern m
opaque	-	milchig, trüb, undurchsichtig
opaque to heat	-	wärmeundurchlässig
opaque to light	-	lichtundurchlässig
opaque to infrared (rays)	-	infrarotundurchlässig

opaque to ultrared (rays)	- ultrarotundurchlässig
particle accelerator	- Teilchenbeschleuniger m
periphery	- Umfang m, Umkreis m, Peripherie f
power supply	- Netzanschluss m, Zuleitung f; Stromversorgung f; Energieversorgung f
projectile ('prədʒiktail)	- Geschoss n, Projektil n
quarter period	- Viertelperiode f
radioactive disintegration	- radioaktiver Zerfall, radioaktive Umwandlung
recording device	- Registrierapparat m
semicircular	- halbrund, halbkreisförmig, Halbkreis...
split, to	- (auf)spalten, teilen; - (chem)abspalten, sich zersetzen
target nucleus	- Zielkern m, Targetkern m
transmutation	- Umwandlung f, Transmutation f (Atomkerne)
waste product	- Abfallprodukt n, Abfallerzeugnis n

GRAMMAR and NOTES

1. This property of discharging an electrified body is found to be due to the fact that these rays produce ions in the gas through which they pass.

   Such substances are said to be radioactive. Uranium and its salts have been found to give off alpha, beta, and gamma rays.

Infinitiv

Aktiv	Passiv
to test - prüfen	to be tested - geprüft werden
to have tested - geprüft haben	to have been tested - geprüft worden sein.

Der Infinitiv mit to steht abweichend von der entsprechenden deutschen Konstruktion

A. als Subjekt:

To measure this current will be very difficult.
Diesen Strom zu messen wird sehr schwierig sein.

B. als Attribut:

The problem to be discussed in this paper is entirely new.

a) Das Problem, das in diesem Artikel erörtert wird,...
b) Das Problem, das in diesem Artikel erörtert werden soll,...
c) Das in diesem Artikel zu erörternde Problem ...
... ist völlig neu.

C. als Objektskasus mit dem Infinitiv:

The failure caused the designers to modify the appliance.
Der Fehler (Das Versagen) veranlasste die Konstrukteure, das Gerät zu verbessern.

Automatic control permits this process to be speeded up.
Die automatische Steuerung gestattet (ermöglicht) es, diesen Prozess zu beschleunigen.

D. als Subjektkasus mit dem Infinitiv:

The transformer is known to be a useful apparatus.

a) Man weiss, dass der Transformator ein nützliches Gerät ist.
b) Es ist bekannt, dass der Transformator...
c) Bekanntlich ist der Transformator ein...
d) Der Transformator ist als ein nützliches Gerät bekannt.
e) Der Transformator ist bekanntlich...

After this treatment, the material is then said to be magnetic or magnetizable.

a) Man sagt dann, dass das Material nach dieser Behandlung magnetisch oder magnetisierbar sei.
b) Nach dieser Behandlung nennt man das Material...
c) Das Material wird nach dieser Behandlung als magnetisch oder magnetisierbar bezeichnet.

E. als "for-Konstruktion":

Diese Konstruktion kann verschiedene Positionen im Satz einnehmen. Auf "for" folgt ein Akkusativobjekt, danach ein Infinitiv (meist mit "to"):

There is a tendency for these tiny currents to cancel one another out.

Es besteht die Tendenz, dass sich diese winzigen Ströme gegenseitig aufheben.

For an isolated atom to alter its state, it must absorb a photon.

a) Damit ein isoliertes Atom seinen Zustand ändern kann, muss es ein Photon absorbieren.
b) Um seinen Zustand zu verändern, muss ein isoliertes Atom ein Photon absorbieren.
c) Zur Aenderung seines Zustandes muss ein isoliertes...

The safety inspector must arrange for safety devices to be installed on all machines.

Der Sicherheitsinspektor muss dafür sorgen, dass an allen Maschinen Sicherheitsvorrichtungen angebracht werden.

2. Word Study.

fissile	-	spaltbar;spaltfähig
fissile fuel	-	Kernbrennstoff m
fissility	-	Spaltbarkeit f
fission	-	Kernspaltung f
fission chain reaction	-	Kettenspaltung f, Spaltungskettenreaktion f
fissionability	-	Spaltbarkeit f
fissionable (U.S.)	-	spaltbar

Fissile - capable of undergoing nuclear fission.
Fission - the process of splitting a nucleus into two parts.
Fission chain reaction is a reaction in which the fission of an atom causes the successive fission of other nuclei.

EXERCISES

1. Change the following sentences:

Example:

a) It is very difficult to measure this current.
b) To measure this current is very difficult.

It will certainly be possible for them to solve this problem. It will hardly be possible to tell in advance what the results of this experiment will be. It will be simple to determine the frequency of a radio wave.

2. Change the sentences by using the "for-construction" beginning with:

There is no need ...; There is the tendency ...; It will be necessary ...

Industry tends to be concentrated in a single region. Cast iron tends to fracture under excessive tension. They will have to study the fundamentals of electrical engineering. It is not necessary that the operator knows the theory behind the operation of his machine.

3. Translate into German:

A two-winding transformer is known to consist of two coils so arranged that the magnetic lines of force of one coil pass through the other. Electrons, atoms, and molecules are known to possess quantized magnetic dipole moments. If a computer is required to make a calculation or to solve a problem, it has to be fed with the necessary information. This electronic computer is believed to be the most complicated one in our research laboratory. The nucleus of an atom is thought to be made entirely of protons and neutrons, electrons being absent. This method permits information to be read by both man and machine. The new test has shown the material to be very hard. There is no need for this to be so. It will hardly be possible for them to solve this problem. The characteristic

values to be determined will be calculated by a computer. The amount to be paid is rather large. To simplify the process will be the function of this new device.

4. Translate into English:

1) Hohe Temperaturen zu messen ist die Aufgabe von Thermoelementen.
2) Sicherheitsbestimmungen zu beachten ist von überragender Wichtigkeit.
3) Der zu zahlende Betrag ist ziemlich gross.
4) Das Instrument, das von unseren Ingenieuren konstruiert werden soll, hat grosse praktische Bedeutung.
5) Diese Vorrichtung gestattet es, die Spannung nach Belieben zu verändern.
6) Er wird die Grundlagen der Elektrotechnik studieren müssen.
7) Es ist wichtig, dass die Diskussion offen und ehrlich geführt wird.
8) Der Wärmeverlust wird als vernachlässigbar angesehen und bleibt unberücksichtigt.
9) Wenn man von einem Computer verlangt, dass er eine Berechnung ausführt oder ein Problem löst, (dann) müssen ihm die notwendigen Informationen eingegeben werden.

NUCLEAR REACTORS

A nuclear reactor or pile (from the shape of early models) serves to convert nuclear energy (atomic energy) into thermal energy. The two principal categories into which they may be divided are:

a) thermal reactors, in which the fission is produced by neutrons of thermal energies, and

b) fast reactors, in which the fission chain is supported by neutrons of energies more than 1 MeV. There are also intermediate reactors using neutrons with energies of a few hundred electronvolts.

The nuclei of atoms consist, broadly speaking, of the elementary particles named protons and neutrons. The protons have a positive electric charge, whereas the neutrons have no charge, i.e., they are electrically neutral. Very powerful forces of attraction act between these particles (collectively referred to as "nucleons") and hold them together in the nucleus. Heavy atomic nuclei are, however, not so stable as light ones, because in the former the repulsive forces exerted by the protons loosen the structure of the nucleus. For this reason it is possible to cause fission of heavy nuclei — such as those of uranium 235 — by bombarding them with free neutrons. The "fission products" travel at considerable velocity, collide with matter somewhere in the reactor, and give off their kinetic energy as heat. This is the conversion of nuclear energy into heat. In addition to the fission products and heat formed in the fission of uranium, however, two fresh neutrons are also formed, which in turn can cause the fission of more uranium atoms. In this way the chain reaction is initiated.

Necessity for a Moderator

A piece of pure U 235 will support a fission chain reaction with neutrons of all energies. For thermal neutrons, the critical size is very small and for fast neutrons it is somewhat larger. Most of the neutrons released in the fission of U 235 — and other fissile materials — have energies between 1 and 2 MeV. A chain reaction in natural uranium is practicable only if the fast neutrons released in the fission process are reduced to thermal energies before they are lost. For this reason the fissile material in a natural uranium reactor is mixed with a moderator — a material in which neutrons are retarded by repeated elastic collisions, without appreciable absorption. The moderator may be intimately mixed with the fissile material, forming a homogeneous reactor, or may be distributed through it in separate pieces, making a heterogeneous reactor. Low-velocity neutrons are much better suited to split atoms than high-velocity neutrons are. The slower neutrons can interact with the uranium nucleus for a greater length of time, whereas faster neutrons are in the vicinity of the nucleus for too short a time to initiate the fission process. The velocity of the neutrons is moderated by causing them to collide with light atoms, large numbers of which must be incorporated in the reactor for this purpose. Materials consisting of such light atoms are, for example, graphite and water. The neutrons which have been slowed down in this way will then cause fission of further U 235 nuclei. Each fission process gives birth to fresh neutrons, so that the chain reaction is self-sustaining and the reactor is consequently kept in operation.

Requirements for Nuclear Reactor

The principal requirements for a nuclear reactor may now be summarized as follows:

a) a supply of fissile material,
b) in a thermal reactor, a moderator,
c) devices for controlling the rate at which the chain reaction proceeds,
d) arrangements for removing the heat generated by the operation of the reactor,
e) a shield to contain the radiations emitted by the reactor,
f) arrangements for removing the radioactive fission products from time to time.

Nuclear Reactors for Power Production

The nuclear reactor has great potentialities as a source of energy. Once the chain reaction has begun, the rate at which it continues is limited only by the capacity of the cooling system to take away heat. A power level of 1000 kW requires a consumption of U 235 or Pu 239 of about a gramme per day and the problem of putting this concentrated fuel to practical use has been studied from several angles.

The development of mobile reactors, suitable for driving ships and submarines, is well advanced.

THE ATOMIC POWER PLANT

By a bit of simplification, the reactor can be described as an atomic furnace that supplies the heat from which electricity is generated. There are some long rods suspended along the wall. They are graphite cylinders with uranium-loaded tips, and the few dozens are enough of a reserve to keep the plant going for six months or more. Uranium is a very rich power producer. How rich, may be judged from the following figures: the plant uses 30 grammes of uranium in 24 hours where a thermal power plant of the same capacity (5000 kW) would require as much as 100 tons of coal. At the same time, the plant utilizes only some 25 per cent of the heat released by the fission process.

The fission process is based on the disintegration properties of the uranium nucleus. The neutrons released by disintegrating nuclei penetrate into other nuclei and split them too, and so it goes on. This chain reaction extends to all the rods and gives off a colossal amount of heat. This heat is taken up by the flow of water in the thin-walled steel tubes running through the core of each of the rods. The water is driven under tremendous pressure — 100 atmospheres — and therefore does not boil though it leaves the reactor at a temperature of 270°C. In passing through the rods, the water becomes radioactive and consequently dangerous to personnel. For that reason it circulates in a closed circuit, known as the primary contour, communicating its heat through heat exchangers to the water in the secondary contour, which is thus converted into steam for driving the turbine.

That is how atomic energy is transformed into electrical energy. This is, of course, only a very general outline of the process, which is remarkable for its combination of complexity and simplicity.

QUESTIONS

1) What is a reactor?
2) What kinds of reactors do you know?
3) What are reactors used for?
4) What is a nucleon?
5) What do we mean by "heavy atomic nuclei"?
6) How is it possible to cause fission of heavy nuclei?
7) What is the conversion of nuclear energy into heat?
8) By what means is the chain reaction initiated?
9) How is the velocity of the neutrons moderated?
10) What do we call "light atoms"?
11) What does each fission process cause?
12) When is the reactor kept in operation?
13) What requirements are there for nuclear reactors?
14) What is a nuclear power plant?

IMPORTANT TERMS

contour ('kɔntuə)	- Form f, Umriss m; Aussenlinie f, Umgrenzungslinie f
give off, to	- abgeben; locker werden, sich lockern (Schraube)
graphite ('græfait)	- Graphit m
incorporate, to	- einbauen, unterbringen; inkorporieren
interact, to	- in Wechselwirkung stehen; einwirken

intermediate reactor	- intermediärer (mittelschneller) Reaktor
intimate mixture	- inniges Gemisch
loosen, to	- lösen, lockern; auflockern; abschrauben
mobile ('məubail)	- beweglich, fahrbar, ortsveränderlich, transportabel
moderator	- Moderator m, Bremsstoff m, Bremsmittel n
moderator control	- Bremsmittelregelung f, Moderatorkontrolle f (des Reaktors)
moderator heat	- Moderatorwärme f
nuclear reactor	- Kernreaktor m, Reaktor m
nucleon	- Nukleon n, Kernbaustein m
release, to	- freigeben, auslösen, loslassen
shield	- Abschirmung f, Schild m; Schutzschirm m
tip	- Spitze f, Kontaktspitze f; Kopf m; Bestückung f
uranium fission	- Uran(kern)spaltung f

GRAMMAR and NOTES

1. Wortbildung

Neue Wörter werden gebildet durch:

1. Ableitung

1.1. ohne Ableitungssilben: to turn - the turn

1.1.1. Formengleichheit von Substantiv und Verb:
the effect - to effect
the telephone - to telephone

1.1.2. Formengleichheit von Adjektiv und Substantiv:
dark - the dark
current - the current

1.1.3. Formengleichheit von

Adjektiv und Verb: clear - to clear
cool - to cool

1.1.4. Formengleichheit von

Substantiv, Adjektiv
und Verb: light - Licht; hell; erleuchten, entzünden

1.1.5. Formengleichheit von

Substantiv, Adjektiv,
Adverb, Präposition,
und Verb: round - Runde; rund; herum; um... herum; (sich)runden

1.2. mit Ableitungssilben: to transform - the transformation

1.2.1. mit Vorsilben (Präfixen) - bei fast allen Wortarten möglich

dis- - disadvantage, to disappear
in-/im- - incorrect, impossible
mis- - mistake, to misunderstand
re- - re-entry, to re-cover; to react
un- - unable, to unload

1.2.2. mit Nachsilben (Suffixen)

- age (bei abstr. Subst.): leakage (von: to leak)
- al (bei Adj. u. Subst.): natural (von: nature)
  arrival (von: to arrive)
- ance (bei abstr. Subst.): performance (von: to perform)
- en (bei Adj. u. Verben): woolen (von: wool)
  to strengthen (von: strength)
- ent (bei abstr. Subst.): propellent (von: to propel)
- er (bei konkr. Subst., Personenbezeichnungen, Akt. Bauelementen, Geräten): teacher (von: to teach)

	rectifier (von: to rectify)
	loudspeaker (von: to speak loud)
- ion (bei abstr. Subst.):	connection (von: to connect)
- ism (bei abstr. Subst.):	magnetism (von: magnet)
- less (bei Adjektiven) :	powerless (von: power)
- ly (bei Adv., selten Adj.) :	simply (von: simple) friendly (von: friend)
- ment (bei Subst.) :	replacement (von: to replace)
- ness (bei abstr. Subst.):	darkness (von: dark)
- or (bei Subst. wie bei-er) :	generator (von: to generate)
- ssion (bei abstr. Subst.):	emission (von: to emit)
- sion (bei abstr. Subst.):	corrosion (von: to corrode)
- tion (bei abstr. Subst.):	reduction (von: to reduce)

1.3. mit Umlaut: long - the length

1.4. mit Ablaut: to bind - the bond

2. Zusammensetzung von:

2.1. ganzen Wörtern: air-cooled, water-moderated reactor

2.2. (Anfangs-)Silben: megamp, coax, hi-fi

2.3. (Anfangs-)Buchstaben: maser, PVC

3. Verkürzung:

omnibus - bus

ampere-meter - ammeter

4. Verwendung von Eigennamen:

faradization

5. Bedeutungswandel:

paper - Papier; Bedeutungserweiterung zu:
Artikel, Veröffentlichung;
Zeitung; Tapete

Weiter Beispiele zur Ableitung mit Nachsilben:

1. Bildung von abstrakten Substantiven:

to perform	- ance	performance
to induce		inductance
to assist	- ant	assistant
to mechanize	- ation	mechanization
to classify	- cation	classification

2. Bildung von Adjektiven:

to control	- able	controllable
to neglect	- ible	negligible
to solve	- uble	soluble
to effect	- ive	effective
to converge	- ent	convergent
the angle	- ar	angular
the automation	- ic	automatic
the gas	- ous	gaseous

3. Bildung von Verben:

simple	- ify	to simplify
the magnet	- ize/-ise	to magnetize
the length	- en	to lengthen

2. **SYMBOLS FOR PHYSICAL QUANTITIES**

NUCLEAR SCIENCE

Term	Symbol
albedo	β
atoms, number of,/volume of a particular element or compound	N
atoms, number of,/volume of a mixture ..	N'
average binding energy per nucleon in a nucleus	$\bar{B}$
average cosine of angle of scatter in laboratory system	$\bar{\mu}$
average diffusion coefficient in slowing down theory	$\bar{D}$
average number of fast neutrons per fission	ν
average number of fast neutrons emitted as a result of thermal fission per thermal neutron absorbed in a fuel	η
average logarithmic energy loss per neutron collision with a nucleus	ξ
form factor	
axial	a_z
radial	a_r
buckling of neutron flux	B^2
buckling of neutron flux, geometrical ..	B_g^2
buckling of neutron flux, material	B_m^2
build-up factor for Compton scattering ..	B
cadmium ratio	R_{Cd}
collision density/energy/interval	F(E)
conversion factor	C
cross-section, macroscopic	Σ
cross-section	σ
decay constant	λ
diffusion length	L

energy required to form one ion pair	W
enrichment factor	E
extrapolation distance of neutron flux at the boundary between a medium and free space	d
extrapolation length	Λ
fast fission factor	ϵ
fast neutron density in two-group diffusion theory	f
Fermi age	τ
gain factor of fissile material	g
half-life of radioisotope	T, $T_{\frac{1}{2}}$
isotopic number	I
isotopic spin	T
lethargy	u
level width	Γ
linear absorption coefficient	μ
maximum fractional decrease in neutron energy after an elastic scattering collision	α
mean free path	$\lambda \ldots l$
mean life of radioisotope	t_m
migration length	M
multiplication factor for an infinite system	$k \ldots k_\infty$
multiplication factor for a finite system	k_{eff}
natural concentration of fissile material	C_0
neutron density	n
neutron density, fast	f
neutron density, thermal	n
neutron, flux	ϕ
neutron lifetime	l
neutron magnetic moment	μ
neutrons, number of	n
neutrons in nucleus (A-Z), number of	N
radius, nuclear	R, r
reactor period	T
resonance escape probability	p

slowing down density	q
slowing down length	L_s
stopping power, relative, ratio of	S
thermal utilization factor	f

Subscripts to Symbols for Quantities

referring to	Subscript
neutron absorption	a
neutron activation	act
neutron capture	c
neutron coherent scattering	coh
neutron elastic scattering	s
neutron fission	f
neutron inelastic scattering	i
neutron transport	t
fast neutrons	f
thermal neutrons	n
free atom	fa
resonance	res
total	T
extrapolated value of a length	e

OTHER MODIFYING SIGNS

For processes involving neutrons and nuclei, the type of nucleus will be indicated in parentheses by its chemical symbol following the symbol describing the process.

e.g. $\sigma_a(U)$; $\sigma_a({}^{235}_{92}U)$; $\sigma_a(D_2O)$; $\lambda_s(U)$

If the neutron energy is not indicated, as in the above, it will be assumed to be that corresponding to the most probable velocity of a Maxwellian spectrum at 20°C. If it is necessary to indicate the neutron energy, this may be done by a subscript or superscript attached to the symbols.

EXERCISES

1. Change the following words into verbs:

Example:

length - to lengthen.

Wide, strength, moist, simple, solid, just, summary, minimum, special, moderate, seperate, approximate, large, rich, able.

2. Change the following expressions into adjectives:

Example:

to allow - allowable
week - weekly
wool - woolen etc.

To measure, to obtain, to convert, hope, use, harm, month, friend, rain, grass, stone, child, green, wood, south, north, west, east.

3. Change the following words into nouns:

Example:

to assist - assistance
correct - correctness
to translate - translator

To exist, to prefer, to observe, to formulate, to discuss, to predict, to measure, to agree, to use, to pass, strict, kind, thick, to visit, to study, to assist, to address, to employ, to plan, to read, to swim.

4. Translate into English:

1. Man weiss, dass die Sonne eine Masse komprimierter Gase darstellt.
2. Man nimmt an, dass ein Vakuum ein idealer Wärmeisolator ist.
3. Der Transistor, der für diese Forschungsarbeit verwendet werden soll, muss von höchster Qualität sein.

4) Die Wärmemenge, die zugeführt werden muss, muss gross genug sein, um das Metall zu schmelzen.

5) Die bei diesem Versuch zu verwendenden Apparate sind sehr leistungsfähig.

6) Den Prozess zu vereinfachen wird die Aufgabe dieser neuen Vorrichtung sein.

Lesson Twenty

STRENGTH OF MATERIALS

Types of Loading.

With reference to the manner in which loads are applied or transmitted to a structure or machine, the loads will be considered under three distinct headings: namely, static loads, repeated loads, impact and energy loads.

1. Static, steady or dead loads are forces that are applied slowly and not repeated,and remain nearly constant after being applied to the body, or are repeated relatively few times, such as the loads on most buildings or the load applied to a bar in the usual type of testing machine.

2. Repeated loads are forces that are applied a very large number of times causing a stress in the material that is continually changing, usually through some definite range. The loads applied to the connecting rod of an engine when the engine is running and the wheel loads on a railroad rail as a train passes over the rail are repeated loads.

3. Impact loads are forces that are applied to the resisting body in a relatively short period of time. An impact load, in general, is applied by a body that is in motion when it comes in contact with the resisting body, and the force exerted by the moving body and the period during which it acts in general cannot be determined. For this reason in some problems it is more satisfactory to calculate the stress and strain produced by an impact load from the energy delivered to the resisting body by the moving body. When this is done, the energy delivered to the resisting body is called an energy load and is expressed in foot-pounds (1 ft lb = 1.356 J = 0.138 kpm).

Other Classifications of Loads.- Loads may be classified as distributed loads and concentrated loads. A distributed load may be uniformly distributed or non-uniformly distributed. Thus, if sand is spread on a floor so that its depth is constant, the floor is subjected to a uniformly distributed load, whereas if the sand is distributed so that its depth is not constant, it is said that the floor carries a non-uniformly distributed load. A concentrated load is one whose area of contact with the resisting body is negligible in comparison with the area of the resisting body.

The more common types of loads to which structural and machine members are subjected may be classified as central loads, torsional loads and bending loads. A body may be subjected simultaneously to loads of any two or to all three of these types.

A central load is a load whose action line passes through the centroid of the area on which the stresses are to be considered, or a distributed load whose resultant passes through the centroid of the area. The stress produced by a central load may be any one of the three types, tensile stress, compressive stress, shearing stress.

The distinguishing feature of a central load that acts on a straight bar of constant cross section as compared to torsional and bending loads is that the stress in the bar, as it may be assumed, is uniformly distributed over the cross-sectional area; that is, the intensity of stress (unit stress) may be assumed as constant.

Forces that cause a bar to twist about its central axis are called torsional loads.

A beam is a bar or member that is bent by forces acting perpendicularly to the axis of the bar. Such forces are called transverse or cross-bending loads.

Tension and Compression.- Experiments have shown that for nearly all structural materials the unit stress in a material is approximately proportional to the accompanying unit strain of the material, provided that the unit stress does not exceed a value called the proportional limit.

Hooke's Law

Hooke's law states that the unit stress in a material is proportional to the accompanying unit strain, provided that the unit stress does not exceed a certain value. If, for example, the unit stress is doubled or trebled, the accompanying unit strain also is doubled or trebled. It is a statement of the experimentally determined fact that the first part of the stress-strain curve is a straight line. The law may be expressed mathematically as follows:

$$\sigma/\varepsilon = \text{a constant}$$

It is found experimentally that materials used in most load-resisting members act elastically only for stresses corresponding to the straight-line portion of the stress-strain diagram, and hence the statement frequently is made that Hooke's law applies only in the "elastic range" of the material. Besides, in the so-called elastic range, it applies, however, to compressive stresses and strains and to shearing stresses and strains as well as to tensile values.

The modulus of elasticity of a material is defined as the numerical value of the constant ratio of the unit stress and the accompanying unit strain for the material. Thus, if it is denoted by the symbol E, it may be defined by the expression

$$E = \frac{\sigma}{\varepsilon}$$

and, when the stress and deformation are caused by axial loads, the preceding expression may be written as follows:

$$E = \frac{\frac{P}{a}}{\frac{e}{l}} = \frac{Pl}{ae}$$

The shearing modulus of elasticity denoted by the symbol E_s is similarly expressed as

$$E_s = \frac{\tau_s}{\epsilon_s} = \frac{\tau_s}{\phi}$$

The values of τ_s and ϵ_s (or ϕ), however, can be found most easily from the results of a torsion test.

Ultimate Strength. *Elastic Limit*

If the load on the bar increases still further, the unit stress and unit strain increase if the material is ductile, until the maximum unit stress is reached, which is called the *ultimate strength*. A brittle material breaks when stressed to the ultimate strength whereas a ductile material continues to stretch. The ultimate strength of a material, then, is defined as the maximum unit stress that can be developed in the material, as determined, from the original cross section of the bar or specimen; the cross section of a bar of ductile material decreases somewhat as the bar is stressed above the yield point.

After the ultimate strength of a ductile material is developed, the bar begins to "neck down" thereby rapidly reducing the area of cross section at the neck-down section and the load required to cause the bar to continue to stretch decreases. The load on the bar at the instant of rupture is called the *breaking load*. The breaking load divided by the area of the neck-down section is the value of the unit stress in the bar when rupture occurs, and this value is considerably greater than the ultimate strength since the cross-sectional area decreases more than the load decreases as necking down occurs.

Elastic Limit.- If the load on the bar is released after the bar has been stressed beyond the *yield point*, the bar will not return to its original length but will retain a part of its deformation. The deformation per unit of length retained by the bar after the load (and stress) has been reduced to zero is called the *permanent* set or merely the set. The elastic limit of a material is defined as the maximum unit stress that can be developed in the material without causing a permanent set.

Factor of Safety

Working Stress.- A tensile test diagram gives very valuable information on the mechanical properties of a material. Knowing the limit of proportionality, the yield point and the ultimate strength of the material, it is possible to establish for each particular engineering problem the magnitude of the stress which may be considered as a safe stress. This stress is usually called the working stress. For brittle materials such as cast iron, concrete, various kinds of stone and for such material as wood, the ultimate strength is usually taken as a basis for determining the working stresses.

The magnitude of the factor of safety depends very much upon the accuracy with which the external forces acting upon a structure are known, upon the accuracy with which the stresses in the members of a structure may be calculated and also upon the homogeneity of the materials used.

Shearing Force and Bending Moment. Definition of Beams and Types of Loading

A bar acted upon by forces or couples in an axial plane, which chiefly cause bending of the bar, is termed a beam. Beams are usually classified as follows according to the manner of support and loading.

Simple Beams.- A beam freely supported at the ends is termed a simple beam.

Beams in Pure Bending.- When a beam or a portion of a beam is acted on by couples only, it is said to be in pure bending.

Cantilever Beams.- If the beam is supported only at one end by being built into a wall or supported, it is called a cantilever beam.

Beams with Overhanging Ends.- A beam may be freely supported at two points and have its end portion (or portions) extend beyond the support; it is then known as a beam with an overhanging end.

Statically Indeterminate Beams.- Beams may also be built into walls at both ends, or at one end and freely supported at the other, or may rest on several supports. Such beams are statically indeterminate, i.e. the magnitudes of the supporting forces or reactions cannot be determined by statics alone.

Types of Loading.- Frequently the load is distributed over part of the length or the entire length of the beam. If the distributed load is of uniform intensity over the beam, it is called a uniformly distributed load. Or the distributed load may be of varying intensity and it is called a uniformly varying load.

Shearing Force and Bending Moment.- The action or force causing two contacting parts or layers to slide upon each other, moving apart in opposite directions parallel to the plane of their contact is called a shearing force.

A moment tending to distort a structural element from the straight or from its proper curvature is known as a bending moment. When a man walks over a beam supported at both ends, the beam is acted on by a bending moment. The reactions in the support must be in equilibrium with the force exerted on the beam by the man's weight. The top layers of the beam will be under compression and the bottom ones under tension; if nothing else than a bending moment acts on the beam, the neutral layer will pass through the centre of gravity of the beam's cross section. The bending moment is positive if it produces bending of the beam concave upward and the shearing force is positive if the right portion of the beam tends to shear downward with respect to the left.

TORSION

If two opposing couples act on a rod in planes perpendicular to it, then the rod is subjected to torsion. The twisting moment is called the torque. Consider a circular shaft built in at the upper end and twisted by a couple applied to the lower end. It can be shown by measurements at the surface that circular sections of the shaft remain circular during twist, and that their diameters and the distances between them do not change provided the angle of twist is small. As for the state of stress within the shaft, the assumption will now be made that not only the circular boundaries of the cross sections of the shaft remain undistorted but also that the cross sections themselves remain plane and rotate as if absolutely rigid; that is, every diameter of the cross section remains straight and rotates through the same angle. The tests of circular shafts show that the theory developed on this assumption is in very good agreement with the experimental results.

COLUMNS

Lateral Buckling of Bars Compressed within the Elastic Limit.

There is a certain critical value of the compressive force at which large lateral deflection may be produced by the slightest lateral load. For a prismatical bar built-in at the bottom and loaded axially at the top, this critical compressive force is

$$P_{cr} = \frac{\pi^2 EI}{4l^2}$$

Experiments show that when the compressive force in a slender (when the strut is not slender enough, lateral buckling occurs at a compressive stress above proportional limit) strut approaches this value, lateral deflection begins and increases so rapidly with increase of the compressive force that a load equal to the critical value is usually sufficient to produce complete failure of the structure. Consequently, this critical load must be considered as the criterion of strength for slender columns and struts.

QUESTIONS

1) What types of loading are there?
2) What is shearing force?
3) What does Hooke's law state?
4) What is meant by "ultimate strength"? "elastic limit"?
5) What may be considered as a safe stress?
6) When does "permanent set "occur?
7) It it necessary to know the moment of inertia to calculate the shear produced by bending?
8) When does a structure become statically indeterminate?
9) How are beams usually classified?
10) What do we mean by the deflection of a beam?
11) When is the bending moment positive?
12) What do we understand by "torsion"?

IMPORTANT TERMS

angle of twist	- Torsionswinkel m, Verdrehungswinkel m, Drehwinkel m
bending moment	- Biegemoment n
breaking load	- Bruchbelastung f, Bruchlast f
brittle	- spröde, brüchig; mürbe
buckling	- Ausbeulen n, Beulen n, Ausknicken n, Krümmung f
cantilever beam ('kæntili:və...)	- Freiträger m, Kragträger m,
columm	- (arch)Pfeiler m, Säule f, Stütze f; (print) Kolumne f, Rubrik f, Spalte f; (math)Kolonne f; (mach tools) Maschinenständer m
compression strain	- Verformung f unter Druck

compressive strength	-	Druckfestigkeit f
compressive stress	-	Druckbeanspruchung f, Druckspannung f
compressive yield point	-	Quetschgrenze f
couple	-	Paar n; Kräftepaar n
cross section	-	Querschnitt m; (nucl) Wirkungsquerschnitt m
curvature ('kə:vətʃə)	-	Krümmung f, Biegung f, Wölbung f
deformation	-	Verformung f, Formänderung f, Deformation f
ductile ('dʌktail)	-	dehnbar, streckbar, biegsam; plastisch, (kalt)verformbar
Euler's formulae for columns	-	Eulersche Knickformeln f/pl
extensometer	-	Dehnungsmesser m
freely supported	-	beweglich gelagert, frei aufliegend
freely suspended	-	frei aufgehängt
lateral load	-	Seitenschub m, seitliche Belastung, Querkraft f
load (ləud)	-	Beanspruchung f, Belastung f, Last f
load resistance	-	Belastungswiderstand m
loading	-	Beanspruchung f, Belastung f; Beladen n
member	-	(gen)Mitglied n; (mach etc.) Bauglied n, Bauteil n; Konstruktionteil m; Stab m, Element n (Fachwerk); Glied n; Organ n
modulus of elasticity	-	Elastizitätsmodul m
neck down, to	-	einengen, bündeln; absetzen (Durchmesser nahe dem Ende verringern)
permanent set	-	bleibende Vorformung, Dehnungsrest m
rigid	-	starr, unbiegsam, steif; formhaltig

shear, to	- (ab)scheren, (ab)schneiden
shear	- Schere f; Schub m; Scherkraft f; Gleitung f; Schiebung f
shearing force	- Schubkraft f, Scherkraft f
shearing modulus of elasticity	- Elastizitätsmodul m für Schub, Schubmodul m, Schubsteife f
shearing strain	- Gleitung f, Schiebung f
shearing stress	- Scherspannung f, Scherbeanspruchung f; Schubspannung f
slender beam	- schlankster Träger
statics	- Statik f, Mechanik f, ruhender Körper; atmosphärische (elektrische) Störungen f/pl
strength of materials	- Werkstoffestigkeit f; Festigkeitslehre f
stress-strain curve (diagram)	- Spannungs-Dehnungskurve f; Spannungs-Dehnungsdiagramm n
strut (strʌt)	- Strebe f, Stütze f, Verstrebung f
strut beam	- Stützbalken m, Verstrebungsbalken m
tensile stress	- Zugspannung f
tensile test specimen	- Probekörper m für Zugversuch, Zerreissprobe f
torque	- Drehmoment n
torsion	- Torsion f, Verdrehung f, Drillung f
torsion test	- Torsionsversuch m, Verdrehungsversuch m
treble, to	- verdreifachen
twist	- Verdrehung f, Torsion f; Verdrillung f
twisting moment	- Drillmoment n, Torsionsmoment n, Verdrehungsmoment n
unit strain (U.S)	- Dehnung f
unit stress (U.S.)	- Spannung f

yield point - Fliessgrenze f; Quetschgrenze f, Streckgrenze f

Young's modulus (of elasticity) - Elastizitätsmodul m, E-Modul m

GRAMMAR and NOTES

1. Loads may be classified as distributed loads and concentrated loads.
   The stress produced by a central load may be any one of the three types, tensile stress, compressive stress, shearing stress.
   Impact loads are forces that are applied to the resisting body in a relatively short period of time.

Das Partizip.

	Aktiv	Passiv
Präsenspartizip:	measuring	being measured
Perfektpartizip:	having measured	having been measured

Ebenso wie das Präsenspartizip kann das Perfektpartizip seine verbale Funktion verlieren und zum reinen Adjektiv werden.

A. Das Partizip als Attribut vor dem Bezugswort:

I. The remaining amount of energy is very small.
Die verbleibende Energiemenge ist sehr gering.

II. The stored energy can be used in various ways.
Die gespeicherte Energie kann auf verschiedene Weise genutzt werden.

B. Das Partizip als Attribut nach dem Bezugswort zur Verkürzung relativer Nebensätze:

I. The current flowing in a conductor is measured in amperes.
Der Strom, der in einem Leiter fliesst, wird in Ampere gemessen.

oder: Der in einem Leiter fliessende Strom...

II. We used all the methods recommended.

Wir benutzten alle Methoden, die empfohlen wurden.

oder: Wir benutzten alle empfohlenen Methoden.

c. Adverbial gebrauchtes Partizip (verbunden):

a) temporal: während, wenn, als, nachdem, (und)
b) modal: wobei, indem, (und)
c) kausal: da, weil
d) konditional: wenn

Das Partizip steht ohne eigenes Subjekt. Man verwendet das Subjekt des Hauptsatzes.

I. Using equation (2) we arrive at the following result.

Wenn wir Gleichung (2) verwenden, kommen wir zu folgendem Ergebnis.

oder: Bei Verwendung von Gleichung (2) kommen wir zu folgendem Ergebnis.

oder: Da wir Gleichung (2) verwenden, kommen wir zu folgendem Ergebnis.

II. Being heated magnetized steel loses its magnetism.

oder: When being heated magnetized steel loses its magnetism.

Wenn magnetisierter Stahl erwärmt wird, verliert er seinen Magnetismus.

D. Adverbial gebrauchtes Partizip (unverbunden):

a) temporal: während, wenn, als, nachdem, (und)
b) modal: wobei, indem, (und)
c) kausal: da, weil
d) konditional: wenn
e) konzessiv: obgleich, als ob

Das Partizip hat sein eigenes Subjekt und ist häufig durch Komma vom Hauptsatz getrennt.

I. Copper being a good conductor, we were recommended to use it.

Da Kupfer ein guter Leiter ist, wurde uns empfohlen, es zu verwenden.

oder:...wurde uns seine Verwendung empfohlen.

II. The proper conditions created, we could study the particles possessing tremendous energy.

Als die entsprechenden Bedingungen geschaffen waren, konnten wir die hochenergetischen Teilchen untersuchen.

E. Adverbiale Partizipialkonstruktion gemäss D. (unverbundenes Partizip) durch "with" eingeleitet:

The double-induction generator consists of two mechanically coupled induction machines with their stators connected in series.
Der Doppelasynchrongenerator besteht aus zwei mechanisch gekoppelten Asynchronmaschinen, wobei ihre Statoren in Serie geschaltet sind.

oder: ... bei in Serie geschalteten Statoren.

Anmerkung 1: Als prätikative Ergänzung kann das Perfektpartizip das Subjekt oder das Objekt näher bestimmen.
Als prädikative Ergänzung zum Subjekt wird das Perfektpartizip weniger häufig als das Präsenspartizip verwendet.
Es findet sich in Fügungen wie:

They remained seated(=sitting). Sie blieben sitzen.
He was found injured behind his house.
Er wurde hinter seinem Hause verletzt aufgefunden.

Als prätikative Ergänzung zum Objekt steht das Perfektpartizip mit passivischer Bedeutung

1. nach have und get:
   a) im Sinne von "(veran) lassen":
      She had a new dress made.
      Sie liess (sich) ein neues Kleid machen = Sie bekam ein neues Kleid gemacht.

He should have (or:get) that done.
Er sollte (=müsste) das machen lassen.

b) auch ohne dass ein Veranlassen vorliegt:
He had (or:got) his leg broken.
Er brach sich das Bein.

Bei get kann auch die eigene Ausführung einer Tätigkeit gemeint sein:

Can you get the work finished in time?
Können Sie die Arbeit rechtzeitig fertigbekommen?
I'd like to get that settled.
Ich möchte das erledigt haben (oder: in Ordnung bekommen).
Can you get this text typed?
Können Sie diesen Text mit der Maschine schreiben (lassen)?

Aber: Please have this text typed.
Bitte lassen Sie diesen Text abschreiben.

2. nach Verben der Sinneswahrnehmung
I have never heard it said. (daneben:... heard it say).
Ich habe es niemals sagen hören.
I have often seen it done (=...seen people do it).
Ich habe es oft tun sehen.

3. nach Verben des Wünschens:
How many pounds would you like changed?
Wieviel Pfund möchten Sie gewechselt haben?
I wanted this kept on the blackboard.
Ich wollte, dass dies an der Tafel bleibt.
I want it done. Ich möchte, dass es getan wird.
When do you wish it (to be) finished?

Wann möchten Sie es fertighaben?

4. nach Verben wie keep und leave:
They left no stone unturned.
Sie liessen nichts unversucht.

Anmerkung 2: Das Präsenspartizip mit eigenem Handlungsträger erscheint gleichfalls vor allem

a) nach den Verben der Sinneswahrnehmung als Ausdruck des progressiven Aspekts:
I heard someone laughing. Ich hörte, wie jemand lachte.
We felt the ground trembling. Wir fühlten, wie der Boden erbebte.
I can smell something burning. Ich rieche, dass etwas brennt.

b) nach Verben wie keep, leave, set, catch, find:
She kept (or:was keeping) me waiting.
Sie liess mich warten. (Sie liess auf sich warten).
He has to struggle hard to keep things going.
Er hat sehr damit zu tun, alles in Gang zu halten.
Who has left the water running?
Wer hat das Wasser laufen lassen?
He knew he had to set things going.
Er wusste, dass er die Sache in Gang bringen musste.
He caught them doing nothing.
Er ertappte sie beim Nichtstun.

Als Prädikatsergänzung zum Subjekt steht die -ing-Form hier bei der persönlichen Passivkonstruktion, z.B.:

They were kept waiting. Man liess sie warten.

2. Symbols for Physical Quantities

STRESS ANALYSIS

Term	Symbol
Elasticity	
Co-ordinate systems	
cartesian	x, y, z
cylindrical	r, θ, z
spherical	$r, \theta, \phi; r, \psi . \theta$

general curvilinear	α, β, γ
direction cosines	l, m, n

Displacements, rotations and strains

displacements	u, v, w
rotations	$\bar{\omega}_x, \bar{\omega}_y, \bar{\omega}_z$
direct strains, cartesian	$\epsilon_x, \epsilon_y, \epsilon_z \cdots$ $\epsilon_{xx}, \epsilon_{yy}, \epsilon_{zz}$
volumetric strain $\epsilon_x + \epsilon_y + \epsilon_z$, or $\epsilon_{xx} + \epsilon_{yy} + \epsilon_{zz}$	Δ
shear strains, cartesian	$\gamma_{yz}, \gamma_{zx}, \gamma_{xy} \cdots$ $\epsilon_{yz}, \epsilon_{zx}, \epsilon_{xy}$
direct strains, cylindrical	$\epsilon_r, \epsilon_\theta, \epsilon_z \cdots$ $\epsilon_{rr}, \epsilon_{\theta\theta}, \epsilon_{zz}$
shear strains, cylindrical	$\gamma_{\theta z}, \gamma_{zr}, \gamma_{r\theta} \cdots$ $\epsilon_{\theta z}, \epsilon_{zr}, \epsilon_{r\theta}$
direct strains, curvilinear	$\epsilon_{\alpha\alpha}, \epsilon_{\beta\beta}, \epsilon_{\gamma\gamma}$
shear strains, curvilinear	$\epsilon_{\beta\gamma}, \epsilon_{\gamma\alpha}, \epsilon_{\alpha\beta}$

Forces and stress

components of body force, cartesian	X, Y, Z
direct stress, cartesian	$\sigma_x, \sigma_y, \sigma_z \cdots$ $X_x, Y_y, Z_z;$ $\widehat{xx}, \widehat{yy}, \widehat{zz}$
mean, or hydrostatic, stress $(\sigma_x + \sigma_y + \sigma_z)/3$	$\Theta/3$
shear stresses, cartesian	$\tau_{yz}, \tau_{zx}, \tau_{xy} \cdots$ $Y_z, Z_x, X_y;$ $\widehat{yz}, \widehat{zx}, \widehat{xy}$
direct stresses, cylindrical	$\sigma_r, \sigma_\theta, \sigma_z \cdots$ $\widehat{rr}, \widehat{\theta\theta}, \widehat{zz}$
shear stresses, cylindrical	$\tau_{\theta z}, \tau_{zr}, \tau_{r\theta},$ $\widehat{\theta z}, \widehat{zr}, \widehat{\theta r}$
direct stresses, curvilinear	$\widehat{\alpha\alpha}, \widehat{\beta\beta}, \widehat{\gamma\gamma}$
shear stresses, curvilinear	$\widehat{\beta\gamma}, \widehat{\gamma\alpha}, \widehat{\alpha\beta}$

Stress function and operators

stress function	ϕ, ψ, χ
Laplacian operator $\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}\right)$	∇^2

biharmonic operator $\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}\right)^2$ or equivalent forms in other co-ordinate systems	∇^4

Material constants

modulus of elasticity (direct) or Young's modulus	E
modulus of rigidity, or shear modulus	G
bulk modulus (modulus of compressibility)	K
Poisson's ratio	$\nu \ldots \sigma$
Lamé's constants	λ, μ

NOTE. Lamé's constants, which arise from the expression of the strain energy function for an isotropic solid in the form

$$2W = \lambda(\Sigma \epsilon_x)^2 + 2\mu\Sigma\epsilon_x^2 + \mu\Sigma\gamma_{yz}^2$$

are related to Young's modulus and Poisson's ratio by the equations

$$\lambda = \nu E/(1+\nu)(1-2\nu); \ \mu = E/2(1+\nu)$$

Notation for thin plates

thickness of plate	h, t
flexural rigidity of plate, $Eh^3/12\ (1-\nu^2)$	D
direct forces in middle plane of plate	$N_x, N_y; T_1, T_2$
shear force in middle plane of plate	N_{xy}, S
shear forces normal to plate surface	$Q_x, Q_y \ldots N_1, N_2$
bending couples acting in planes zx and yz (M_x or G_1 is a couple about the axis y)	$M_x, M_y \ldots G_1, G_2$
twisting couple acting on plane x about axis y or on plane y about axis x	$M_{xy} \ldots H$

EXERCISES

1. Change and translate the following sentences:

Example:

a) Materials which conduct electricity are termed conductors.

b) Materials conducting electricity are termed conductors.
Stoffe, die Elektrizität leiten, werden Leiter genannt.

1) An electric motor is a machine which converts electrical energy into mechanical energy.
2) In primary batteries the electric current is obtained directly from the chemicals which constitute the cell.
3) A transformer consists of two windings that are placed on the same iron core.
4) Current which enters the ground from an electrode will spread out in all directions.
5) The physical constant that characterizes the material of the conductor is called specific resistance.
6) The size of engine that is required for any given purpose can be determined.

2. Connect both sentences by means of participial construction and translate them:

Example:

The voltage was investigated experimentally.
It was induced in a winding.
= The voltage induced in a winding was investigated experimentally.
Die in einer Wicklung induzierte Spannung wurde experimentell erforscht. Oder: Die Spannung, die in einer Wicklung induziert wird, wurde experimentell erforscht.

1. Radio waves are emitted from a conductor. It carries an electric current.
2) The parts are held in an evacuated chamber. The parts are welded.
3) The spark passes between the electrodes. It ignites the fuel.
4) A vacuum tube is a device. It consists of a number of electrodes.

5) The new transistor was developed in this laboratory. It was tested last week.
6) There are enormous oil deposits.They lie under the surface of the earth.

3. Change the sentences and translate them:

Example:

a) The earliest transistors were rather unreliable and could only be employed in very simple circuits.

b) Being rather unreliable, the earliest transistors could only be employed in very simple circuits.
Da die ersten Transistoren sehr unzuverlässig waren, konnten sie nur in sehr einfachen Schaltungen eingesetzt werden.

1) When electrical devices are connected so that the current is not divided at any point, they are said to be connected in series.
2) He used time to the best advantage, he completed his engineering course in four years.
3) The instrument partly lost its former efficiency, as it had been used for a long time.
4) Since he saw that the spark plugs were dirty, he cleaned them.
5) As they wished to find out the cause of the breakage, they examined the device in all its details.

4. Translate into English:

1) Wenn das Ergebnis des Experiments annehmbar ist, muss es veröffentlicht werden.
2) Wenn ein elektronischer Rechner als Ganzes betrachtet wird, stellt er ein beeindruckend kompliziertes Gerät dar.
3) Da die Körper mehr Energie abstrahlen, als sie aus der Umgebung aufnehmen, kühlen sie ab.
4) Wenn man die Grundlagen der Elektrotechnik studiert, muss man ein klares Verständnis vom Begriff des elektrischen Stromes und der EMK erlangen.
5) Ein elektrischer Zug benötigt im allgemeinen mehrere hundert Ampere, wenn er startet und die Geschwindigkeit erhöht.

Lesson Twenty-one

MACHINE ELEMENTS

Fastenings.- Machine parts are held together by parts:

a) working in tension,
b) working in shear,
c) creating friction, and
d) using both shear and friction forces.

Types of Fastenings.- All fastenings can be divided into two classes: disconnectable fastenings and permanent joints.

Disconnectable fastenings, in turn, are effected by:

a) bolts and screws,
b) wedges,
c) dowel pins,
d) keys.

Permanent joints are obtained by means of:

a) press fits,
b) shrink fits,
c) rivets,
d) welding, brazing and soldering and
e) casting.

KEYS.- The main function of a key is to transmit torque between a shaft and a machine part assembled on it. In most cases keys prevent relative motion, both rotary and axial. In some constructions keys allow an axial motion between the shaft and the hub; such keys are called feather or spline keys. According to various characteristics, keys can be distinguished as straight and tapered; rectangular, dovetailed, chamfered, round, and disk-shaped; radial and tangential, and (according to their use) for light duty and for heavy duty.

Riveted Joints.- Riveting has been the standard method of joining plates and structural parts before welding began to replace it with increasing rapidity. Rivets are made of tough and ductile low-carbon or nickel steel. Brass rivets are used only cold and in small sizes.

BEARINGS

A bearing is a machine part which supports a moving part and confines its motion. That part of a shaft which rotates in a bearing is called a journal. Bearings in which one rubbing surface slides over another are called plain bearings and may be divided into two classes; Those with a continuous rotary motion and those with an intermittent motion. To the first class belong journal bearings, which carry a load acting at right angles to the shaft axis, and thrust bearings, which take a load acting in the direction of the shaft axis. To the second class belong bearings of parts having a rocking motion, as wrist pins, or a linear reciprocating motion, as crossheads. The latter can be considered as rocking parts with an infinitely large radius of the bearing surface. Bearings with a continuous rotary motion form the great majority of all bearings. They are also the only ones in which an oil-film pressure adequate to support the journal can be created by the journal itself. Bearings with an intermittent motion must depend for proper operation either upon an outside source for obtaining the necessary oil pressure or upon an abundant oil supply and a low specific bearing pressure.

Bearings with Rolling Contact.- In a bearing with rolling contact the shaft is supported on rollers or balls. A bearing of this type has the theoretical advantage of reduced friction, but to be practical it must fulfil the following conditions:

a) unavoidable sliding should be reduced to a minimum;
b) the rolling elements must be properly guided in their motion;
c) all rolling elements should be of exactly the same size;
d) the rolling elements and their guides or raceways must be extremely hard and be very smoothly polished;

e) the pressure should be approximately normal to the surface of contact;

f) in order to avoid distortion, the rolling elements must not be overloaded.

Classification.- Bearings with rolling contact may be divided into two main classes according to the type of rolling elements used:

1) ball bearings and
2) roller bearings with cylindrical, conical, spherical, or concave rollers.

Each of the above classes may be subdivided into the following types:

a) radial bearings;
b) thrust bearings, and
c) radial-thrust or angular bearings which can take both radial and axial forces.

Ball Bearings.- Each radial ball bearing consists of four elements:

1) an inner ring or race, grooved on its outer surface;
2) an outer race grooved on its inner surface;
3) steel balls and
4) a ball retainer or cage for spacing the balls so that they do not touch each other, thus reducing wear and noise.

Types:

a) a single-row radial bearing usually made with a deep groove;
b) an angular-type bearing, which can take an axial load in addition to the radial load;
c) a double-row bearing;
d) a self-aligning double-row bearing, the inner surface of the outer race of which is part of a sphere.

GEARING

Friction Gearing.- Friction gears depend for their driving action upon the friction of the driving wheel, or driver, against its mate, or follower.

Toothed Bevel Gearing.- Bevel gears are used to connect two shafts whose axes intersect each other. Two types of bevel gearing are in general use, straight-tooth gears and spiral-tooth gears. Bevel gears are not interchangeable and are designed in pairs.

Toothed Spur Gearing.- Toothed gears may be considered as friction gears in which the contact surfaces are provided with grooves and projections, which prevent slip and insure positive means of transmitting rotation. Toothed gears are used when a constant speed ratio is desired and the distance between the shafts is relatively small. Toothed spur gears are used to connect parallel shafts and are suitable for transmission up to the largest power. Spur gearing may be classified as external, internal, and rack and pinion. If the tooth elements are parallel to the shaft axis, the gears are termed straight-tooth spur gears; if the elements are helices, the gears are called helical gears.

Worm Gearing.- Worm gearing is a type of screw gearing used for transmitting power between non-intersecting shafts which are at right angles to each other. By this means higher speed reductions may be obtained in a minimum space. There are two classes of worm gearing in common use, each of which has its advantages: one is a straight or cylindrical worm and the other a worm with a hollow shape similar to that of an hour glass. Due to its nature, worm gearing is used mostly as a speed reducer, the worm being the driving member.

Screw Gearing.- Screw or helical gears, often miscalled spiral gears, are used to connect shafts which are not intersecting. Their axes may be:

a) parallel,
b) at right angles, or
c) inclined at any angle to each other. Type (a) gears are always called helical gears. Worm gears form a special type (b).
In order to preclude confusion with helical spur gears having parallel axes, a better name for those with non-parallel axes, is screw gears. Screw gears resemble helical spur gears by the shape of teeth, but their action is different.

Flywheels.- The purpose of a flywheel is to maintain the speed of a machine which is doing work or absorbing energy at a variable rate, between given limits. A flywheel stores up energy when the latter is supplied at a higher rate than it is absorbed, and gives it out when the reverse is the case. A flywheel can store energy only when its speed is increasing and give it out when its speed is decreasing; therefore the speed must vary, the allowable amount of variation depending upon the conditions of the case.

CLUTCHES

Couplings and Positive Clutches

General Considerations.- A coupling is used to connect two shafts permanently; it is disconnected only for repairs or to make a change in the installation. A clutch permits easy and quick connection and disconnection of two shafts. A clutch is also used instead of a key to connect the shaft with a revolving part, such as a pulley or a gear. Couplings are made in two main types: rigid and flexible. Clutch constructions are based on the positive action and friction principles.

Friction Clutches.- The object of a friction clutch is to connect a stationary machine part to a rotating part, to bring it up to speed, and to transmit the required power with a minimum of slippage. In certain cases a friction clutch serves as a safety device by slipping when the torque transmitted through it exceeds a safe value, thus preventing the breakage of parts in the transmission train.

Design Requirements.- The following considerations must be observed in the design of a clutch:

a) Selection of a type suitable for given operating conditions.
b) Selection of materials forming the contact surfaces.
c) A sufficient torque capacity.
d) Transmission of the motion without shock.
e) Quick disengagement without drag.
f) Provision for holding the contact surfaces together by the clutch itself.

g) Low weight in order to keep down the inertia, especially in high-speed service.

h) Balancing of all moving parts, especially in high-speed service.

i) Provision for taking up wear of the contact surfaces.

j) Accessibility and provisions facilitating repairs.

k) In an industrial clutch, absence or protection of projecting parts.

l) In a clutch frequently or continuously operated, provision for carrying away the heat generated at the contact surfaces.

Classification.- Friction clutches may be divided into two main groups, according to the direction of the acting force: axial clutches and radial or rim clutches.

Axial clutches are those which have the contact pressure applied in a direction parallel to the axis of rotation. Axial clutches, in turn, can be subdivided into:

a) cone clutches,

b) disk clutches, and

c) combined cone and disk clutches.

In rim clutches the contact pressure is applied upon a rim in a radial direction. These clutches, like brakes, may be subdivided into band clutches and block clutches, also into external, internal and combined internal-and-external clutches. Magnetic clutches are usually of the disk type. A friction clutch used to connect two shafts is often termed a clutch coupling or friction coupling.

FRICTION FUNDAMENTALS

All of the effects of friction involve force. The same force which keeps stationary objects in place tends to retard objects in motion. Basic concepts of the two corresponding types of friction are static and dynamic. The first is simply a tangential force associated with a normal force and no work is done. The second involves both force and speed, and energy is expended. A friction element is on a rotating drum; mechanical energy is converted directly to heat at the rubbing surfaces by virtue of friction, giving the immediate effect of increasing the temperature of the rubbing materials. Several factors contribute to the phenomenon of friction. These are adhesion, cohesion, abrasion and elastic deformation.

Wear Rate.- The subject of wear is a broad one, since it is affected by many complex interrelated factors. There appears, however, to be a very close relation between the wear of a particular material and the amount of work done in the braking or clutch application. Under conditions which are not extreme, the rate of wear of a constantly dragging friction element will increase in nearly a straight line with increasing speed. Similarly, the work done by a friction element dragging at a constant speed and variable pressure will increase in direct relation with pressure. Higher temperature of the rubbing surfaces causes higher wear rate. High-temperature resistance to wear is increased in molded linings by increasing the amount of inorganic material, such as metals, graphite, oxides, and ceramics, in the lining.

QUESTIONS

1) What kinds of fastenings do you know?
2) By means of what are permanent joints obtained?
3) What is the main function of a key?
4) What is a riveted joint?
5) What kinds of bearings are there?
6) Why do bearings grow hot when they are not lubricated?
7) What kinds of gears do you know?
8) Can a cogwheel engage a rack?
9) What is the difference between a coupling and a clutch?
10) What is a friction clutch?
11) What is the function of a shaft?

IMPORTANT TERMS

arc welding	- Lichtbogenschweissen n
ball bearing	- Kugellager n
bearing	- (mach)Lager n
bevel gear	- Kegel(zahn)rad n, konisches Getriebe
bolt	- Schraube f, Bolzen m; Riegel m
cam	- Nocken m, Kurve f; Daumen m, Exzenter m
clutch	- (aus- und einrückbare) Kupplung f, Schaltkupplung f
cogwheel	- Zahnrad n, Kammrad n, Kron(en)rad n
collar bearing	- (mach) Kammlager n, Halslager n
coupling	- Kupplung f, Kopplung f; Muffe f
crosshead	- Kreuzkopf m; Traverse f, Querträger m, Spanntraverse f
flange coupling	- Flanschkupplung f
flywheel	- Schwungrad n; Schwungscheibe f (Kupplung)
friction clutch	- Reibungskupplung f
gas welding	- Gasschweissung f; autogene Schweissung
gear	- Getriebe n; Gang m; Zahnrad n
jaw clutch (dʒɔ:klʌtʃ)	- Backenkupplung f
key	- (mach) Längskeil m, Feder f; Schlüssel m; Taster m (Telegraf)
lever ('li:və)	- Hebel m, Arm m, Kurbel f, Schwinge f (Getriebelehre)
machine element	- Maschinenelement n, Maschinenteil n
mount, to	- montieren, zusammenbauen; aufstellen; aufspannen (Werkzeug)
muff (mʌf)	- Muffe f
pulley ('puli)	- Flasche f, Rolle f; Flaschenzug m; Scheibe f, Trommel f
raceway	- Kugellaufbahn f; Kabelkanal m, Leitungskanal m

rack	Zahnstange f; Gestell n, Gerüst n
radial ball bearing	Radiallager n, Querlager n
resistance welding	Widerstandsschweissen n
roller bearing	Rollenlager n, Walzenlager n
screw (skruː)	Schraube f; Bolzen m; Gewindespindel f; Schnecke f
shaft	(mach) Welle f
sleeve	Muffe f; Büchse f; Buchse f; Manschette f
slippage	Rutschen n (Kupplung)
spindle	Spindel f; Laufspindel f (Turbine)
spur gear	Stirnrad n
thread (θred)	Gewinde(gang m) n; Windung f (Schraube); Faden m
turn	Windung f (einer Wicklung); Drehung f; Umdrehung f
washer	Unterlegscheibe f; Abdichtungsring m
wedge	Keil m; Backe f; Kegelstück n
worm	Schnecke f
worm gear	Schneckenrad n

GRAMMAR and NOTES

1. Two types of bevel gearing are in general use, straight-tooth gears and spiral-tooth gears.

THE HYPHEN (—)

Hyphens are often used

a) to join the words which are most closely related (groups of modifiers):

a water-cooled stainless-steel condenser = a condenser made of stainless steel and cooled by water

high-energy particles = particles of high energy

a diesel-powered electricity generating station = a station which generates electricity and which is powered by diesel engines magnetic energy-storage devices = magnetic devices for storing energy; solid-state physics = the physics of the solid state

Note 1: Adverbs may be used in groups of modifiers (qualifying words): a sufficiently rapid cooling process = a process of cooling which works with sufficient rapidity.

Note 2: Proper names.

The names of people may be used as modifiers (without apostrophes):
the Bohr atom = the atomic structure proposed by Bohr; a Bessemer converter = a converter of the type developed by Bessemer
the Kelvin scale = the scale invented by Kelvin.

But proper names are not used as modifiers (qualifying words) in the names of laws, theories, theorems or diseases:

Maxwell's equations
Newton's laws
Pascal's theorem
Einstein's theory
Darwin's theory
Mach's principle

Parkinson's disease

b) to avoid possible ambiguities:
This umbrella needs to be re-covered (to re-cover = wieder bedecken [Schirm etc.])
but: She has recovered (to recover = sich erholen von)
a small - car factory = a factory for making small cars
a small car factory = a small factory for making cars

c) in words joined together to form a kind of compound adjective conveying a special meaning or idea:

This technique is up to date. But:
This is an up-to-date technique.
A never-to-be-forgotten sight.

This radio operates at high frequency. But:
This is a high-frequency radio.
the lower-priced articles (die billigeren Artikel).
She was sharper-eyed than usual (Sie war scharfsichtiger als gewöhnlich)
a kind-hearted man (ein gutherziger Mann)
the most old-fashioned ideas (die altmodischsten Vorstellungen)
narrow-minded (engstirnig)

d) in chemical compositions:

Two metallic alloys recently developed for superconductivity are niobium-zirconium and niobium-titanium.

e) in compound expressions:

Radioactive materials may emit α-particles, β-particles and γ-rays.

The x-and y-co-ordinates are plotted automatically.

f) in attributive compound numerical modifiers:

a 6-cylinder diesel engine,
two 2-cm pipes,
a 15-ton hoist,
an 8-hour day, but also: a three hours(') programme.

g) to make fixed compounds of words which, though compounded in sense and by usage, have not yet coalesced as a single unit:

son - in - law, pl. sons - in - law
commander - in - chief (Oberbefehlshaber)
lookers - on (Zuschauer)
goings - on (Vorgänge)
passers - by (Vorübergehende)
book - keeper (Buchhalter)
women - doctors (Aerztinnen)
grown - ups (Erwachsene)
forget - me - nots (Vergissmeinnicht)
good - for - nothings (Taugenichtse)
have - nots ("Habenichtse", Besitzlose) etc.;
he - goat (Ziegenbock), she - goat (Ziege),
cock - sparrow (Sperling[männl.])
hen -sparrow (Sperling[weibl.]) etc.

h) sometimes after prefixes (ex-, vice-, sub-, non-, anti-, post-, pre-, pro- etc.):

vice-admiral (compounds with vice - have, as a rule, double stress),
vice - consul ('vais 'kɔnsəl),
ex-service, ex-husband, ex-wife (when the prefix is stressed)
sub-lieutenant ('sʌble'tenənt),
ex-president (Ex-Präsident, ehemaliger Präsident)
anti-Jacobin, but Antichrist
anti-freeze (Frostschutzmittel), but antifriction (Mittel gegen Reibung),
non-directive (ungerichtet),
post-selection (Nachwahl),
pre-loading (Vorspannung), aber preadjusted (vorher eingestellt),
pro-Canadian (when the word-base is a name [proper noun] a hyphen separates the word-base and the prefix).

i) to make words more easily read where two similar letters come together:

pre-eminence, re-enter, re-elect, co-operate, co-ordinate.

Usage is divided on words made with co-, the more common ones now generally being written solid:

cooperate, coordinate etc. Sometimes diaresis is used in these words: coöperative, reëdit, reädjust.

j) in constructions noun + gerund or noun + agent:

ship - building, ship - builder;
baby - sitting, baby - sitter

k) to mark the division of a word at the end of a line of manuscript or print. But note:

1) Words of one syllable cannot be divided (this includes verbs such as "worked")
2) Words of more than one syllable can be divided only between syllables. (Consult the dictionary)
3) Suffixes of fewer than three letters should not be separated from the rest of the word.

4) Never divide a word so that only one letter stands at the end of the line.

5) Hyphenated words should be divided only at the hyphen.

l) in compound numerical modifiers from twenty-one to ninety - nine and in written fractions:

sixty-five, eighty-two, twenty-one;
four -fifths, seven-twelfths;
two-thirds rule, three-quarter-hour intervals (fractions that are expressed as adjectives)

m) with the words half and quarter when they are used as prefixes:

half-moon, half-mast, quarter-back, quarter-deck

n) in compounds with self:

self-supporting ('self-sə'pɔːtiŋ) [double stress].
self-acting (selbsttätig, automatisch),
self-activated (selbstaktiviert)

o) in composite adjectives (when used attributively). They may be:

1) adjective + adjective (red-hot, dark -blue), or
2) noun + adjective (pitch-dark, sky-high), or
3) adjective + participle (easy-going), or
4) noun + participle (weight-carrying, English-speaking countries); or

Noun + participle compounds are specially likely to need clarifying hyphens, e.g.:
the tailor-made dresses,
submarine-cable-laying ships.

5) verb + adverb (made-up, fly-over).

Note: Compound modifiers following a noun are usually not hyphenated: She was a well-dressed woman, but: The woman was well dressed. She was a smartly dressed woman.
The practice of hyphenating words varies, and , moreover, dictionaries differ about which compounds should be hyphenated. The rules are complex and variable. The present

tendency is to omit the hyphen and treat the unit as one word. There is, however, one principle that seems to command at least lip service from all authorities. This is that the hyphen is not an ornament but an aid to being understood, and should be employed only when it is needed for that purpose.

"I am in revolt about your hyphens" wrote Sir Winston Churchill to Sir Edward Marsh. "One must regard the hyphen as a blemish to be avoided wherever possible."

EXERCISES

1. Translate into German:

   A vacuum is assumed to be a perfect non-conductor of heat. New techniques in the use of microphones, of recording, and of sound cutting and combining, have made it possible for soft-voiced singers to be heard by millions. It is unthinkable to the social-minded scientist not to be interested in the effects of his discoveries. The level of liquids in sealed cans will be clearly established by X-rays. We found that the pipe was covered with dollar-size electrolysis spots.

2. Translate into English:

   1) Die angeführten Resultate beruhten auf wiederholten Versuchen. Sie waren in allen Fällen gleich.
   2) Wenn die Temperatur des geschmolzenen Eises steigt, wird die Bewegung seiner Moleküle beschleunigt.
   3) Wenn die Stromverteilung über den Leiterquerschnitt ungleichmässig ist, vergrössert sich der Widerstand.
   4) Da er ein geschulter Techniker ist, wusste er, wie man den Fehler in der Anlage feststellt.
   5) Der Funke, der an den Elektroden überspringt, entzündet den Brennstoff.

Lesson Twenty-two

CIVIL ENGINEERING

(American)

General Features.-The men who planned and directed the building of such projects as the Egyptian pyramids, the Roman highways and aqueducts, bridges, canals, and harbors were given the title of architect, meaning chief builder. The early architect was thus responsible not only for what is now included under architecture, but also for what is included under civil engineering.

During this same period the men who constructed roads, bridges, and other such works for the armies were called ingeniarii by the Romans, and until the 16th century the term for engineering meant military engineering. About the 18th century, men who devoted themselves to planning and constructing public works began calling themselves civil or civilian engineers. The first man to advertise himself as a civil engineer was John Smeaton, an Englishman, who in 1761 designed and built the Eddystone lighthouse.

The civil engineer's profession embraces many fields. He builds tunnels, dams, reservoirs and aqueducts to store and transport water for large centers of population and to irrigate desert lands. He protects the quality of the water of streams by treating and disposing of human and industrial wastes and he further purifies this water when it is used for domestic or industrial purposes. The use of soils for dams, levees and other earth structures or for foundations resulted in a division of "soil mechanics". Scientific use of materials for construction is within his field of interest.

He constructs and operates pipelines for transporting gas, water and solids in suspension. He provides facilities for harbors and the navigation of rivers and lakes including docks, canal locks and dams. He builds airfields for civilian and military aircraft throughout the world, including the arctic where runways require great thickness to insulate against thaw of permanently frozen soils. The construction, operation and reconstruction of bridges, yards and terminals of railroad systems are part of his work.

The work of the civil engineer is frequently of a pioneering character. The man entering this profession must have a scientific attitude and have imagination, initiative and good judgment, acquired by experience and college work. He should be able to work with men and the public.

Buildings.- The civil engineer plans, designs, and constructs houses, skyscrapers and large industrial buildings that enable cities to expand vertically as well as horizontally. The skyscraper is an engineering triumph, its existence being due largely to advances in structural design and metallurgical engineering. Its great height was made possible through the development of skeleton-frame construction, in which a stable system of structural-steel members and, in recent years, of reinforced-concrete members supports curtain walls as well as floor and roof loads.

The civil engineer plans the space, structure, and equipment to produce the environment and facilities for efficient production in industrial buildings. To create a plant with optimum working conditions, he must carefully consider and coordinate such items as site selection, parking facilities, public transportation, cafeterias, sanitary facilities, light, heat, air conditioning, and acoustics.

Transportation.- The civil engineer develops transportation and terminal facilities, allowing passengers and goods to move freely within and between cities with a minimum of inconvenience and expense. Transportation development consists of the planning, location, and design of highways, expressways, and parking facilities, of rapid transit systems and railways, of transmission systems and pipelines, of airports, and of the improvement of waterways and harbors.

The design of highways and expressways is dictated by terrain features, the degree of development of the area to be traversed, availability of right-of-way, and the existing and potential traffic volumes. Adequate sight distances must be provided and sharp curves eliminated in order that traffic may operate safely and economically at reasonably high speeds.

The civil engineer plans, designs, and constructs bridges. To eliminate hazardous intersections on modern highways, bridges pass either over or under streets or railways.

The civil engineer designs, constructs, operates, and manages canal locks, dams, ports, harbors, and navigational facilities.

The main feature of air travel is speed, requiring airports to be located so that they are easily and quickly accessible to the cities they serve. It is the responsibility of the civil engineer to plan, design, construct, and maintain civil and other airports.

Water.- An adequate and safe supply of water and the disposal of human and industrial wastes are as essential to community life and urban development as office and industrial buildings and transportation systems. The civil engineer who plans, designs, and constructs a water supply and sanitary system to collect, treat, and distribute public water supplies and to handle household and factory wastes plays an important role in the safeguarding of public health. So important is this branch of civil engineering to public health that it is sometimes combined with the related field of preventive medicine to form a specialty designated as public health engineering.

Many localities depend on the importation of water from outside the immediate area. Modern civil engineering design has made it practicable to transport large quantities of water over considerable distances.

Reclaiming arid lands and controlling rivers for agricultural and power purposes require a diversity of structures such as dams, power plants, canals, and associated facilities.

Other Fields.- The civil engineer is concerned with the problems accompanying advances in atomic energy. He designs and builds the structures necessary to develop atomic power. He has the responsibility of protecting workmen and the public against atomic radiation through the design of shielding structures. He provides for the safe treatment and disposal of atomic wastes. He designs structures to shield the public from radioactive fallout and to withstand the blast of atomic explosions.

__Use of Computers__.- Each civil engineering activity requires the collection of large quantities of data and the determination therefrom of the most effective (optimum) design. In this respect, civil engineering is a decision-making operation. The civil engineer is called upon to determine the feasibility of a project, alternative locations, competitive materials, performance versus cost, safety and reliability, means for preserving such natural resources as air and water, and probable course of future changes. In making these decisions, he must utilize imagination, judgment, intuition, and experience.

With the large amount of information involved, the civil engineer often uses the computer to help evaluate alternatives. The large-scale automatic data processer is ideally suited for this role, because it is basically a logical device and an information organizer. Much of the information handling and processing formerly performed within engineering firms by large numbers of technicians is now accomplished efficiently by the computer. Operations include computation, secondary decision making (the kind made by technicians), drafting and data display, searches for alternative designs, storage of complete files of previous information, exhaustive checking and testing of solutions, and communications.

Many civil engineering calculations can be reduced to the solution of equations that characterize mathematically the engineering process involved. These equations are frequently solved on the computer by use of mathematical approximations. Generally, the more precise the computations, the more computer time required, with consequent larger expenditure of funds for computer usage. In programming the problem for the computer, the civil engineer, therefore, considers use of the computer on the basis of the accuracy of the solution compared to the cost of acquiring this increased accuracy. After reaching a decision as to the level of precision to be sought, the engineer must then exercise careful judgment in the interpretation of the results from the computer.

Among the areas of civil engineering practice affected by the computer are bridge design and analysis, building design, earthquake- and blast-resistant design of structures, area computations in highway earthwork design, analysis of traffic surveys, soil analysis, slope stability of earth embankments, complex surveying computations, critical path scheduling of a construction project, analysis of fluid flow in sewer and drainage systems, and the computer-assisted drawing of blueprints.

QUESTIONS

1) What do we understand by "civil engineering"?
2) How do Americans spell words ending in -our?
3) How do they spell words like "centre" or "theatre"?
4) How many fields has the civil engineer's profession?
5) What do civil engineers build?
6) What do we call "soil mechanics"?
7) What is meant by "skyscraper"?
8) Of what does transportation development consist?
9) By what features is dictated the design of highways?
10) What is the main feature of air travel?
11) What do we mean by "public health engineering"?
12) Why is the use of computers in civil engineering activity important?

IMPORTANT TERMS

air-conditioned	-	klimatisiert
air-conditioning	-	Klimaanlage f, Klimatechnik f
air-conditioning plant	-	Klimaanlage f
airfield (airport)	-	Flughafen m, Flugplatz m
aqueduct (ˈækwidʌkt)	-	Aquädukt m
arid	-	dürr, trocken
architecture (ˈɑːkitektʃə)	-	Architektur f, Baukunst f
blast	-	Detonation f, Explosion f
blueprint	-	Blaudruck m, Blaupause f, Lichtpause f; Bauplan m

canal lock	Kanalschleuse f
civil engineer	Bauingenieur m
civil engineering	Bauingenieurwesen n
condition of the soil	Bodengestaltung f, Art f des Gebirges
construct, to	(er)bauen, errichten, anlegen, bilden, konstruieren
curtain wall	Abschirmmauer f
dam	Damm m, Stauanlage f, Talsperre f, Staumauer f
design, to	entwerfen, (er)bauen, konstruieren
designer	Konstrukteur m, Erbauer m, Gestalter m
designer engineer	Konstrukteur m
display	Darstellung f, Ausstellung f, Vorführung f
drafting (U.S.)	Zeichnen n
draftsman (U.S.)	Zeichner m
draughtsman	Zeichner m
earth embankment	Erdaufwurf m, Erddamm m, Erdwall m, Schüttdamm m
earthquake	Erdbeben n
facilities	Einrichtungen f/pl
harbor (U.S.)	Hafen m
highway	Autobahn f, Hauptstrasse f, Chaussee f; (comput) Hauptweg m, (el) Sammelschiene f
irrigate, to	bewässern, berieseln
levee ('levi)	Deich m, Wall m
pipeline	Rohrleitung f, (Oel)fernleitung f
radioactive fall-out	radioaktiver Niederschlag
rapid-hardening cement	schnell erhärtender Zement, schnellbindender Zement
reinforced concrete	Stahlbeton m
reinforced-concrete construction	Eisenbetonbau m

reinforced-concrete structure	-	Eisenbetonkonstruktion f
right of way	-	Durchfahrtsrecht n
runway	-	Piste f, Start- und Landebahn f
schedule, to (Br. ˈʃedjuːl; Am. ˈskedʒul)	-	planen, eintragen (in Liste)
sewer (ˈsjuə)	-	Abwasserkanal m
sewer system	-	Kanalisation f
shielding	-	Abschirmung f, Schutzbedeckung f
site	-	(gen) Lage f, Ort m; Bauplatz m
site development	-	Grundstückerschliessung f
skeleton construction	-	Skelettbau m, Stahlbau m
skyscraper	-	Hochhaus n, Wolkenkratzer m, Turmhaus n
slope	-	Abhang m, Böschung f, Neigung f, Gefälle n
soil analysis	-	Bodenanalyse f
soil mechanics	-	Bodenmechanik f
structural designer	-	Statiker m
structural engineering	-	Hochbau m
structural steel	-	Baustahl m, Konstruktionsstahl m, Formeisen n
thaw (θɔː)	-	Tau m, Tauwetter n
underground construction	-	Tiefbau m
waste	-	(gen) Verlust m, Schwund m; Abfall m, Ausschuss m, Abfallprodukte n/pl

GRAMMAR and NOTES

The design of highways and expressways is dictated by terrain features, the degree of development of the area to be traversed, availability of right-of-way, and the existing and potential traffic volumes.

a) Das einfache Passiv

to be magnetized - magnetisiert werden
to be seen - gesehen werden

Infinitive

Aktiv	Passiv
to see	to be seen
to have seen	to have been seen

The powder has been succesfully analysed.
Das Pulver ist erfolgreich analysiert worden.

b) Vorgangspassiv und Zustandspassiv

Beachten Sie, dass die Struktur: to be + Perfektpartizip nicht ausschliesslich zum Ausdruck eines Vorgangs dient.

The cable is repaired = 1) Das Kabel wird repariert. (= Vorgang)
2) Das Kabel ist repariert. (= Zustand)

c) Beachten Sie: Während die einfache Form des Passivs die Unterscheidung - Zustand oder Vorgang - je nach Kontext erfordert, bezeichnen die erweiterten Formen stets den Vorgang.

New metals are being developed.
Neue Metalle werden (zur Zeit) entwickelt.

d) Transformation Aktiv → Passiv

We visualize the magnetic field.
The magnetic field is visualized (by us).
A compressed air mechanism moves the plate.
The plate is moved by a compressed air mechanism.

Beachten Sie: Ist der Handlungsträger eine Person, so wird er im passiven Satz weggelassen, wenn er für den Sinn des Satzes entbehrlich ist (z.B. by the firm, by them). Im technischen Englisch jedoch wird mit dem Handlungsträger oft die wichtigste Information des Satzes in den Mittelpunkt gerückt.

e) Transformation Aktiv ⟶ Passiv bei zwei Objekten

Aktiv	We showed the engineers (indirektes Objekt) the test results (direktes Objekt). Wir zeigten den Ingenieuren die Untersuchungsergebnisse
Passiv 1) vom direkten Objekt	The test results were shown to the engineers. Die Untersuchungsergebnisse wurden den Ingenieuren gezeigt.
2) vom indirekten Objekt	The engineers were shown the test results. Man zeigte den Ingenieuren die Untersuchungsergebnisse. Den Ingenieuren wurden die Untersuchungsergebnisse gezeigt.

Beachten Sie: Im Englischen wird vorzugsweise das indirekte Objekt als Subjekt des passivischen Satzes verwendet. Im Deutschen ist eine derartige Transformation nicht möglich. Das englische "persönliche Passiv" wird deutsch meist unpersönlich, aktivisch (mit "man") oder passivisch (mit "es") wiedergegeben.

f) Präpositionales Objekt als Subjekt des Passivsatzes

Aktiv	We sent for the TV technician.
Passiv	The TV technician was sent for*. Man schickte nach dem Fernsehmechaniker. Oder: Der Fernsehmechaniker wurde geholt.

* Vergleiche Relativsätze vom Typ: This is the country he comes from.

EXERCISES

1. Put the following sentences into PASSIVE VOICE:

1) Two experts have tested the new model. 2) Someone will ask you about this procedure. 3) My friend assisted me in selecting the transistor. 4) The firm has sent the price list. 5) They are

developing a new method. 6) The protons and electrons of an atom entirely determine its electrical and chemical properties. 7) Scientists have never changed the early convention as to the direction of current. 8) Chemical action may produce electric currents . 9) We pass current through the solenoid. 10) A conducting wire connected the two bodies together. 11) The free circulation of air will cool the resistor. 12) The body is warming the air. 13) One cannot expect a computer to be an electronic psychiatrist.

2. Translate into German:

1) At first we were shown some of the latest models. 2) How much is he paid a month? 3) They had been given new overalls. 4) I was told that the men were indeed working barehanded on a live wire. 5) If you were asked this question, what would your answer be? 6) These laws are simple and can be relied on. 7) A condition of chemical and electrical equilibrium is thus arrived at and no further action takes place. 8) A north magnetic pole placed at any point in a magnetic field is acted upon by a force tending to move it in a particular direction. 9) It should be investigated whether the new device can be relied upon or not. 10) This matter is very important and should be looked into.

3. Translate into English:

1) Die meisten Elektronen sind fest an die einzelnen Atome gebunden. 2) Elektrische Ströme können durch chemische Reaktionen erzeugt werden. 3) Man sagte ihm, dass die Versuche mit grossem Erfolg abgeschlossen worden seien. 4) Auf diese Resultate kann man sich nicht verlassen. 5) Das Material wird gerade magnetisiert. 6) Der Verbindungsdraht war entfernt worden. 7) Ein elektrisches Feld wird zwischen den Elektroden erzeugt werden.

Lesson Twenty-three

CONSTRUCTION ENGINEERING

(American)

A specialized branch of civil engineering concerned with the planning, execution, and control of construction operations for such projects as highways, buildings, dams, airports, and utility lines.

Planning consists of scheduling the work to be done and selecting the most suitable construction methods and equipment for the project. Execution requires the timely mobilization of all drawings, layouts, and materials on the job to prevent delays to the work. Control consists of analyzing progress and cost to ensure that the project will be done on schedule and within the estimated cost.

Planning. - The planning phase starts with a detailed study of construction plans and specifications. From this study a list of all items of work is prepared, and related items are then grouped together for listing on a master schedule. A sequence of construction and the time to be allotted for each item is then indicated. The method of operation and the equipment to be used for the individual work items are selected to satisfy the schedule and the character of the project at the lowest possible cost.

The amount of time allotted for a certain operation and the selection of methods of operation and equipment are generally determined by the equipment that is readily available to the contractor. After the master or general construction schedule has been drawn up, subsidiary detailed schedules or forecasts are prepared from the master schedule. These include individual schedules for procurement of material, equipment, and labor, as well as forecasts of cost and income.

Execution. - The speedy execution of the project requires the ready supply of all materials, equipment, and labor when needed. The construction engineer is generally responsible for initiating the purchase of most construction materials and expediting their delivery to the project. Some materials, such as structural steel and mechanical equipment, require partial or complete fabrication by a supplier. For these fabricated materials the engineer must prepare or check all fabrication drawings for accuracy and ease of assembly and often inspect the supplier's fabrication.

On most large projects it is necessary to design and prepare construction drawings for temporary construction facilities, such as drainage structures, access roads, office and storage buildings, formwork, and cofferdams. Other problems are the selection of electrical and mechanical equipment and the design of structural features for concrete material processing and mixing plants and for compressed air, water, and electrical distribution systems.

Control. - Progress control is obtained by comparing actual performance on the work against the desired performance set up on the master or detailed schedules. Since delay on one feature of the project could easily affect the entire job, it is often necessary to add equipment or crews to speed up the work.

Cost control is obtained by comparing actual unit costs for individual work items against estimated or budgeted unit costs, which are set up at the beginning of the work. A unit cost is obtained by dividing the total cost of an operation by the number of units in that operation.
Typical units are cubic yards for excavation or concrete work and tons for structural steel. The actual unit cost for any item at any time is obtained by dividing the accumulated costs charged to that item by the accumulated units of work performed. Individual work item costs are obtained by periodically distributing job costs, such as payroll and invoices to the various work item accounts. Payroll and equipment rental charges are distributed with the aid of time cards prepared by crew foremen. The cards indicate the time spent by the job crews and equipment on the different elements of the work. The allocation of material costs is based on the quantity of each type of material used for each specific item.

When the comparison of actual and estimated unit costs indicates an overrun, an analysis is made to pinpoint the cause. If the overrun is in equipment costs, it may be that the equipment has insufficient capacity or that it is not working properly. If the overrun is in labor costs, it may be that the crews have too many men, lack proper supervision, or are being delayed for lack of materials or layout. In such cases time studies are invaluable in analyzing productivity.

Construction Equipment. - A wide variety of relatively heavy machines which perform specific construction (or demolition) functions under power. The power plant is commonly an integral part of an individual machine, although in some cases it is a contained separate prime mover, for example, a towed wagon or roller. It is customary to classify construction machines in accordance with their functions such as hoisting, excavating, hauling, grading, paving, drilling, or pile driving. The selection of a machine for a specific job is mainly a question of economics and depends primarily on the ability of the machine to complete the job efficiently, and secondarily on its availability.

Hoisting Equipment. - This class of equipment is used to raise or lower materials from one elevation to another or to move them from one point to another over an obstruction. The main types of hoisting equipment are derricks, cableways, cranes, elevators, and conveyors.

Excavating Equipment. - This type of equipment is divided into two main classifications: standard land excavators and marine dredges, each of which has many variations.

Standard Land Excavator.-This comprises machines that merely dig earth and rock and place it in separate hauling units, as well as those that pick up and transport the materials. Among the former are power shovels, draglines, backhoes, cranes with a variety of buckets, front-end loaders, excavating belt loaders, trenchers, and the continuous bucket excavator. The second group includes such machines as bulldozers,scrapers of various types and sometimes the front-end loader.

Power Shovel.-This has for years been regarded as the most efficient machine for digging into vertical banks and for handling heavy rock. Generally mounted on crawler treads, the power shovel carries a short boom on which rides a movable dipper stick carrying an open-topped bucket. The bucket digs in an upward direction away from the machine and dumps its load by lowering the front of its hinged bottom.

Front-end Loader.-Loaders are built that can handle buckets having 12, 14, and 20 yd^3 capacities, sizes which some years ago were considered huge even for power shovels. The loader, which is basically an articulated bucket mounted on a series of movable arms at the front of a crawler or rubber-tired tractor, has the advantage of mobility, speed, economy of cost and operation, and light weight. A loader of any given capacity can cost as little as one-half or even one-third as much as a power shovel of the same capacity and requires only one man to run it as opposed to the two or more normally required for the power shovel.

Backhoe.-This is fundamentally an upside-down power shovel. Its bucket, mounted on a hinged boom, digs upward toward the machine and unloads by being inverted over the dumping point. Backhoes are manufactured as individual machines but more often are attachments mounted on a crawler crane, a rubber-tired truck crane, or a tractor (which usually has a front-end loader bucket at the other end). It is particularly well adapted to the digging of deep trenches.

Dragline.-This is a four-sided bucket that is used mainly on soil too wet to support an excavating machine. It is usually carried on a mobile machine, but it can also be worked from a cableway where excavating distances are great. The bucket is carried or cast to a point ahead of its support and dropped to the ground. The dragline is designed to excavate and to fill itself as it is drawn across the ground. It empties when its front end is lowered.

Clamshell.-A clamshell is a two-sided bucket that can dig only in a vertical direction. The bucket is dropped while its leaves are open and digs as they close. Presently many clamshell buckets are attached directly to powered booms, are closed hydraulically, and can work with greater precision in dense soils.

Orange Peel.-This is a multileaved bucket, generally round in configuration. It is normally cable-supported and, like the clamshell, works under its own weight. Like the clamshell, however, it too is being mounted on powered booms and closed hydraulically. One of the commonest uses of the orange peel is the cleaning of small shafts, sewers, and storm drains. Larger sizes are often used for handling broken rock.

Grapple.-This group includes a wide variety of special-purpose tined grabs that work on the principle of the clamshell and orange peel. The grapple is used mainly for handling rock, pipe, and logs.

Excavating Belt Loader.-This type of machine is used mainly for loading granular materials from a stockpile, or as a vertical or inclined belt, or as a pair of chains on which are mounted small buckets. Some belt loaders are mobile and can move into a bank under their own power as the material is moved. Others are fixed and are fed by bulldozers which push material onto the belt from above. Their advantage over most excavators lies in their continuous operation.

Trenching Machine.-This equipment for digging trenches ranges in size from small hand-pushed units used for getting small pipes from streets to private homes to monsters of many tons. All, however, work on basically the same principle: A series of buckets, mounted on a chair or a wheel, lift dirt from the ground and deposit it alongside the trench being dug.

Continuous Bucket Excavator.-This excavator works like a trenching machine but is designed to remove earth and loose rock from a wider area and at shallower depths. These machines are self-propelled; they can load trucks in a continuous operation and can switch from a filled to an empty truck in less than 2 sec. The continuity of loading and the absence of intermittent activities, such as those necessary in shovel or loader operations, make the continuous bucket excavator a fast, economical machine for large excavating jobs.

Combination Excavators and Haulers. - This classification of construction equipment includes bulldozers, carrying scrapers, self-loading or elevating scrapers, and sometimes front-end loaders.

Hauling Equipment. - Excavated materials are moved great distances by a wide variety of conveyances. The most common of these are the self-propelled rubber-tired rear-dump trucks, which are classed as over-the-road or off-the-road trucks. The main difference between these two is weight and carrying capacity.

Graders. - Graders are high-bodied, wheeled vehicles that mount a leveling blade between the front and rear wheels. The principal use is for fine-grading relatively loose and level earth. Commonly considered a maintenance unit, the grader is still an important machine in highway construction.

Pavers. - These place smooth, and compact paving materials. They may be mounted on rubber tires, endless tracks, or flanged wheels. Asphalt pavers embody tamping pads that consolidate the material; concrete pavers use vibrators for the same purpose. Concrete pavers had been required to use forms to contain the material until the advent of the slip-form pavers. These drag their own short forms behind them and consolidate the concrete sufficiently to stand without slumping after removal of the forms.

Drilling Equipment. - Holes are drilled in rock for wells and for blasting, grouting, and exploring. Drills are classified according to the way in which they penetrate rock, namely, percussion, rotary percussion, and rotary. In tunnel work the drills are commonly mounted on platform-supported movable arms or posts that are hydraulically or pneumatically controlled to permit drilling in horizontal or angled positions, with a minimum of effort by the drill operator.

Specialized Equipment. - Among the most common specialized construction equipment are augers, compactors, and pile hammers.

Augers. These are used for drilling wells, dewatering purposes, and cutting holes that can be filled with concrete for foundations.

Compactors.-These machines are designed solely to consolidate earth and paving materials to sustain loads greater than those sustained in the uncompacted state. They range in size from small pneumatic hand-held tampers to multiwheeled machines weighing more than 60 tons. Actual compaction may be achieved by heavily loaded rubber tires or steel rollers. The steel rollers may be solid cylinders, or have separate pads or grids, or contain protrusions (sheep-foot roller).

Pile Hammers.-These machines are used to install bearing piles for foundations, or sheet piles for cofferdams and retaining walls. The prehistoric pile hammer consisted of a heavy weight lifted by a rope and allowed to drop on top of a pile. This drop hammer is still in use, basically unchanged. More efficient modern hammers are true machines activated by steam, air, oil, hydraulic fluid, or electricity. Conventional hammers contain pistons that are raised by one of these means and then either allowed to fall freely because of gravity (single-acting) or to be driven downward by the same means (double-acting) to impart an impact to the pile. Vibratory hammers have been developed which use electrically activated eccentric cams to vibrate piles into place. Relatively rare are machines that use hydraulic action to install piles.

QUESTIONS

1) What do we mean by "construction engineering"?
2) Of what does planning consist?
3) With what does the planning phase start?
4) What does the speedy execution of the project require?
5) For what are construction engineers generally responsible?
6) What is necessary to design and prepare on most large projects?
7) By what means is obtained the cost control?
8) How is it customary to classify construction machines?
9) What types of hoisting equipment do you know?
10) What do we understand by "specialized equipment"?

IMPORTANT TERMS

access road	Zufahrtstrasse f
allot, to	zuteilen, zuweisen
articulated lorry	Sattelauflieger m (aufliegender LKW-Anhänger), Sattelschlepper m mit Anhänger
auger ('ɔːgə)	Bohrer m, Lochbohrer m, Vorbohrer m, Erdbohrer m
backhoe	Tieflöffelbagger m
bearing pile	Druckpfahl m, Stützpfeiler m, Tragpfahl m
bearing-pile foundation	stehende Pfahlgründung
bending machine for reinforcing bars	Betonstahl-Biegemaschine f
block-laying machine	Steinfertigungsmaschine f
boom	Ausleger m, Gurt m, Gurtung f, Ladebaum m
bucket	Eimer m, Kübel m, Baggereimer m, Förderkorbkübel m
bulldozer ('bul,douzə)	Bulldozer m, Planierraupe f, Räumer m, Grossräumpflug m
cable-way	Drahtseilbahn f, Schwebebahn f, Kabelkanal m
cam	Nocke f, Exzenter m, Nocken m, Daumen m
clamshell (bucket)	Greifer m
climbing mixer	Klettermischer m
cofferdam	Fangdamm m, Kastendamm m
compactor (road...)	Erdrammer m, Strassenfrosch m
concrete conveyor	Betonförderer m
concrete mixer	Betonmischer m, Betonmischwerk n
concrete paver	Betonmischmaschine f (US term for concrete mixer)
construction machine	Baumaschine f
continuous bucket excavator	Eimerkettenbagger m
conveyance	Beförderung f, Transport m; Verkehrsmittel n
conveyance of material	Gütertransport m

conveyor (....er)	Transporteur m, Fördergerät n, Förderer m, laufendes Band
conveyor belt	Förderband n
crane	Kran m
derrick	Derrickkran m, (naut) Ladebaum m; Bohrturm m
dewatering	Entwässerung f
discharge gate	Entleerungsschieber m
dragline	Kabelkranschaufler m; Schleppkabel n
dragline excavator	Kabelkranschaufler m, Schürfkübelbagger m
drag conveyor	Stegkettenförderer m, Schleppkettenförderer m
drilling equipment	Bohranlage f, Bohrvorrichtungf
driving shield	Vortriebsschild m, Bohrschild m, Tunnel-Vortriebsmaschine f
to adapt the driving shield system	den Schildvortrieb anwenden
driving shield system	Schildvortrieb m
drop hammer	Fallhammer m, Gesenkhammer m
dump track	Lastwagen m mit Kippvorrichtung
dumper	Motorkipper m, Kippwagen m
egg-layer	Bodenfertiger m
electric tamper	Elektrostampfer m
elevator	Förderwerk n, Elevator m; Aufzug m, Fahrstuhl m
endless bucket trencher	Grabenbagger m (mit Eimern)
excavating	Ausgraben n
excavating belt loader	Gurtfüller m
excavating machine	Bagger m
excavator	Exkavator m, Trockenbagger m
feed bucket (...'bʌkit)	Beschickungskübel m
form work	Fassonarbeit f
front end	Stirnseite f
front loader	Frontlader m

grader	-	Planiermaschine f, Planierer m, Strassenpflug m; Sortiermaschine f
grader roller	-	Planierwalze f
grading	-	Körnung f (Sand); Planierarbeiten f/pl; Sortierung f, Einteilung f
grab	-	Exkavator m, Fänger m, Geschossheber m, Greiferkübel m
grapple	-	Greifer m, Greifschaufel f
grid	-	Gitter n
grinding machine	-	Schleifmaschine f
grouting	-	Zementeinspritzung f, Ausfüllen n mit Mörtel, Bewurf m
hauler	-	Schlepper m
hauling (hɔːliŋ)		Schleppen n, Ziehen n
hauling equipment	-	Transporteinrichtung f
heavy-duty lorry	-	Schwerlaster m, Fernlaster m
hinged (hindʒd)	-	aufklappbar, einklappbar
hinged bottom	-	Klappboden m
hoist	-	Lastenaufzug m, Flaschenzug m, Förderkorbkran m, Hebewerk n
hoisting	-	Aufziehen n, Hissen n
lift truck	-	Gabelstapler m
loading shovel	-	Ladeschaufel f
mixing tower	-	Mischturm m
mobile crane ('moubail [-bil]...)	-	fahrbarer Kran
off-the-road truck	-	Geländelastwagen m
orange peel	-	Exkavator m, Greifkorb m, Greifer m, Greifschaufel f; (bot) Orangenschale f
overrun	-	Ueberschuss m, Uebermass n
pad	-	Stossdämpfer m; Bohrfutter n; Bodenplatte f
payroll	-	Lohnliste f
pile driver	-	Fallwerk n, Ramme f, Rammklotz m
paver	-	Pflasterer m; Betonmischmaschine f; Pflasterstein m; Plattenleger m; Belageinbaumaschine f

percussion drill	Stauchbohrer m, Stossbohrer m
pile driving	Pfahleintreiben n
pile hammer	Ramme f
piling up	Stapeln n
pinpoint, to	genau festlegen oder bestimmen
plasticiser (....zer)	Bodenverflüssiger m
power shovel	Löffelbagger m
prime mover	Antriebsmaschine f, Kraftmaschine f
protrusion	vorstehender Teil; Vorwölbung f, Hervorragen n
rammer	Stampfgerät n
rear dumper	Hinterkipper m
retaining wall	Stützmauer f, (hydr) Staumauer f
roller	Druckwalze f, Rolle f, Roller m, Walzer m
rolling and kneading mixer	Zwangsmischer m
rubber-tired	gummibandagiert
scraper	Motorschürfwagen m, Planierpflug m; Schaber m, Kratzer m
scraping bucket conveyor	Schaufelbecherwerk n
semi-trailer	Sattelauflieger m (aufliegender LKW-Anhänger), Sattelschlepper m
sheep-foot roller	Schaffusswalze f
sheet pile	Spundbohle f
sheet piling	Bohlwand f, Spundwand f
sheet piling of reinforced concrete	Eisenbetonspundwand f
sheet piling of section iron	Profileisenspundwand f
shovel	Schaufel f, Löffel m
sliding moulding machine	Gleitfertiger m
slump	Senkung f, Absackung f, Einsackung f
slump test	Setzprobe f

stacking	-	Stapeln n
stamping unit	-	Schlagaggregat n
star batcher	-	sternförmiger Zuteiler
stone-splitting machine	-	Steinspaltmaschine f
tamper	-	Stampfer m, Stösser m, Erdrammer m
tamping machine	-	Stampfmaschine f
tamping pad	-	Stampfer m
telpher	-	Hängebahn f (zur Beschickung verschiedener Maschinen mit Rohbeton)
thickener	-	Eindicker m
tower crane lift	-	Turmdrehkran m
tractor loader	-	Schaufellader m, Ladeschaufel f
tractor trailer	-	Sattelauflieger m (aufliegender LKW-Anhänger)
trencher (trenching machine)	-	Grabenbagger m
vibrating table	-	Rütteltisch m
vibrator	-	Vibrator m, Rüttelapparat m; (phys) Schwingungserzeuger m
well	-	Brunnen m, Schacht m, Bohrloch n, Treppenraum m, Lichtschacht m

GRAMMAR and NOTES

Since delay on one feature of the project could easily affect the entire job, it is often necessary to add equipment or crews to speed up the work.

As, since, because.

As im Vergleich zu since und because.

As "da" gibt den logischen Grund an: As it was fine, we went for a walk = Da es schön war, machten wir einen Spaziergang.

Since "da (ja, doch)" führt etwas Bekanntes als Grund an:

Since you know it, I need not tell you = Da Sie es (ja) wissen, brauche ich es Ihnen nicht zu sagen.

Because "weil" gibt einen meist noch unbekannten Grund an:

He didn't go to Greenwich, because he had no money. = Er ging nicht nach Greenwich, weil er kein Geld hatte.

Anmerkung: Gelegentlich scheidet der unterschiedliche Grad des Akzents auch die *kausale* Verwendung der Konjunktion *since* von der *temporalen*. Die erstere (="da ja") bleibt dann *unbetont*, während die *letztere* (="seitdem") mit etwas *stärkerer* Betonung gesprochen wird. Vgl. You 'must have 'seen him since you 'passed his 'house (*kausal*) mit: You'must have 'seen him ,since you 'passed his 'house (temporal).

EXERCISES

1. First complete the sentences, using *as* or *since*. Note that in some of the sentences *either as or since* can be used. When you have completed the sentences, indicate those in which *as* or *since* could be replaced by *because*.

1) ..... this transmitter was first designed, there have been many new developments. 2) Communication has become faster ..... the telephone was invented. 3) ..... stated in the previous column, force equals mass times acceleration. 4) The water is cooled ..... it passes through this chamber. 5) ..... the equipment is not ready, the test cannot be performed. 6) ..... originally conceived, the project was not practicable. 7) The carbon in cast iron is present partly ..... free graphite.

2. Complete the sentences, using a phrase with *as* and the appropriate form of the verb in brackets.

Example: Polyvinylchloride is also (know) PVC.
Polyvinylchloride is also *known as* PVC.

1) Granulated plastics polymers (*use*) raw materials in the manufacture of many plastics products. 2) A bridge may (*define*) something which spans a gap. 3) Generating stations which use jet engines to drive the generators (*know*) gas turbine generating stations. 4) A hovercraft can (*use*) a means of transport over land or water. 5) The artificial satellite can (*see*) a small object just above the horizon.

3. Translate into English:

1) Wir werden auf diese Steuerung nicht eingehen, da sie heute fast ausschliesslich für Messschaltungen verwendet wird. 2) Weil er den Fehler gleich hatte finden können, war er imstande, eine bessere Vorrichtung zu konstruieren. 3) Da die Elektroenergie leicht in Wärme umzuwandeln ist, wird die Wärme in vielen Haushalts- und Industriegeräten elektrisch erzeugt. 4) Weil die Monteure der grossen Kälte wegen die Freileitungen nicht werden bauen können, müssen die Arbeiten bis zum Frühjahr verschoben werden.

Lesson Twenty-four

CONCRETE STRUCTURES

(American)

Introduction.- Reinforced concrete is an excellent building material, adaptable to many uses. It is strong, fire-resistant, and durable when well made. On the other hand, it is a heavy material, and its use generally results in rather bulky members so that its greatest field of usefulness is in relatively low buildings and in structures where its mass, rigidity, and strength are advantageous. Tall buildings may be made of reinforced concrete but, when they are more than six or eight stories high, it is desirable to question the economy and advisability of such construction for industrial purposes.

Structures built of concrete should be planned upon the basis of the characteristics of the material itself, and upon the essential nature of the construction processes. Concrete is not a substitute for structural steel in terms of member for member. Architects and engineers, figuratively, should throw away many of their ideas derived from experience with steel-framed structures, then tackle the project at hand on the basis of utilizing the concrete to the best advantage. Many have done this and are now producing plans for concrete structures that are both attractive and practical.

Here, as elsewhere, the designer should make sure that concrete is the most desirable material for a structure and should give careful consideration to the general proportions of the structure and to the uses for which it is intended. Because of the nature of concrete construction, careful planning is needed in the first place because extensive alterations and radical changes of future use are likely to be both difficult and expensive.

Some General Principles.- The planning and the detail designing of concrete structures are so influenced and circumscribed by practical procedures and considerations that the engineer should attack such problems entirely upon the basis of the best use of this particular material. He should remember constantly that, except for possible precast members, he is creating a structure to be made of "artificial stone", of material placed in position in a plastic state so that it must be supported temporarily by something other than itself, and of a material that will and should conform to every detail of the surfaces with which it is in contact when the plastic concrete is deposited.

Not only does concrete improve with the use of good materials, but its quality depends largely upon the excellence of the workmanship used in its manufacture, the adequacy and thoroughness of its placement, and the care with which it is cured. The attainment of the intended high quality is almost completely in the hands of the artisans, who, in the field, convert heaps of aggregates, barrels of cement, and gallons of water into a structure for the use of man. Not only does its strength depend upon highly skilled labor, but the quality of its surface and the beauty of its appearance do likewise.

Precast Concrete.- The use of precast-concrete members and parts of members is a matter that warrants careful study. The possible savings in formwork are obvious, but the handling of heavy pieces in the field may require special equipment. If portions of a structure are to be precast, the original planning should be based upon this fact, and all details should be worked out accordingly. Precast parts can be incorporated in an otherwise poured-in-place structure, but provision should be made for the support of these heavy pieces during construction. Most poured-concrete structures gain much from the stiffness derived from the continuity secured at the junctions of parts, whereas a building made of heavy, loosely connected, precast parts may be inherently undesirable. It is possible, however, to connect precast parts by means of poured sections at the junctions if proper bonding of reinforcement is provided. Although such procedures have not been common in the past, their use should be investigated with an open mind. Because of the possibility of appreciable economies, the use of precast parts will undoubtedly increase in the future.

Prestressed Concrete.- Prestressed-concrete members are useful for certain structures. Their basic purpose is to avoid harmful deformation and cracking when the intended loads are applied.

Concrete Construction.- Concrete construction consists of several operations: forming, concrete production, placement, and curing. Forming is required to contain and support the fluid concrete within its desired final outline until it solidifies and can support itself. The form is made of timber or steel sections or a combination of both and is held together during the concrete placing by external bracing or internal ties. The forms and ties are designed to withstand the temporary fluid pressure of the concrete. The usual practice for vertical walls is to leave the forms in position for at least a day after the concrete is placed. They are removed when the concrete has solidified or set. Slip-forming is a method where the form is constantly in motion, just ahead of the level of fresh concrete. The form is lifted upward by means of jacks which are mounted on vertical rods embedded in the concrete and are spaced along the perimeter of the structure. Slip forms are used for high structures, such as silos, tanks, or chimneys. Concrete production at the job site requires the erection of a mixing plant, and of cement and aggregate receiving and handling plants. Aggregates are sometimes produced at or near the job site. This requires opening a quarry and erecting processing equipment such as crushers and screens.

Concrete is placed by chuting directly from the mix truck, where possible, or from buckets handled by means of cranes or cableways, or it can be pumped into place by special concrete pumps.

Curing of exposed surfaces is required to prevent evaporation of mix water or to replace moisture that does evaporate. The proper balance of water and cement is required to develop full design strength.

Concrete paving for airports and highways is a fully mechanized operation. Batches of concrete are placed between the road forms from a mix truck or a movable paver, which is a combination mixer and placer. A series of specialized pieces of equipment, which ride on the forms, follow to spread and vibrate the concrete, smooth its surface, cut contraction joints, and apply a curing compound.

Steel Erection.- The construction of a steel structure consists of the assembly at the site of mill-rolled or shop-fabricated steel sections. The steel sections may consist of beams, columns, or small trusses which are joined together by riveting, bolting, or welding. It is more economical to assemble sections of the structure at a fabricating shop rather than in the field, but the size of preassembled units is limited by the capacity of transportation and erection equipment.

QUESTIONS

1) Where is the greatest field of usefulness of reinforced concrete?
2) How should be planned structures built of concrete?
3) Is concrete a substitute for structural steel?
4) What do we understand by "steel-framed structures"?
5) Why is careful planning needed?
6) On what does the quality of concrete depend?
7) What is meant by "precast concrete"?
8) Will the use of precast parts increase in the future?
9) When are prestressed-concrete members useful?
10) What is understood by "slip-forming"?

IMPORTANT TERMS

additives for concrete	-	Betonzusatzmittel n/pl
aerated concrete	-	Gasbeton m
aggregate	-	(constr) Körnung f; (tech) Aggregat n, Gerät n; (math) Summe f; (adj) gesamt, total
air-entraining	-	luftporenbildend
anchorage of prestressing tendons	-	Spanngliederverankerung f
arch dam	-	Bogenstaumauer f
assembly	-	Montage f, Zusammenbau m, Aufbau m (aus mehreren Teilen); Gruppe f
batch	-	Menge f, Masse f, Haufen m; Charge f, Partie f

binding agent - Bindemittel n
blast - furnace slags - Hochofenschlacke f
building section - Baulos n
cable duct - Kabelformsteine m/pl
casing - Auskleidung f (eines Schachts), Verkleidung f, Verschalung f, Tübbings m/pl
cast-resin concrete - Giessharzbeton m
cement efflorescences - Zementausblühungen f/pl
cement-slurry layer - Zementschlämmschicht f
cement-water paste - Zementleim m
centrifugability - Schleuderverhalten n
centrifugal process - Schleuderverfahren n
centrifugally cast concrete - Schleuderbeton m
chute, to (ʃu:t) - rutschen
compact, to - verdichten
compaction - Verdichten n
compound - Verbund m, Gemisch n, (Ver)bindung f, Zusammensetzung f; (adj) zusammengesetzt
concrete block ('kɔnkri:t ···) - Betonstein m
concrete-block industry - Betonsteinindustrie f
concrete bridge - Betonbrücke f
concrete casing - Betontübbings m/pl (beim Schildvortrieb), Auskleidung f (eines Schachts)
concrete compaction - Betonverdichtung f
concrete pipe - Betonrohr n
concrete sleeper - Betonschwelle f
concrete trusses (··· trʌsiz) - Betonfachwerke n/pl
concreting - Betonarbeiten f/pl
contraction joint - Schwindfuge f
conveyer pavement - Fliessbandbürgersteig m, Rollgehweg m
cracking tendency - Reissneigung f
crusher - Brecher m, Brechwerk n, Zerkleinerungsmaschine f
crushing strength - Scheiteldruckfestigkeit f
cure, to - (constr) (aus)härten, trocknen
de-icing salt - Tausalz n

dense concrete	dichter Beton
design strength	Gestaltsfestigkeit f
erection	Montage f, Aufstellung, Aufbau m, Zusammenbau m; Errichtung f
erection in the field	Aufstellung f am Betriebsort
expanded light-weight concretes	aufgeblähte Leichtbetone m/pl
exposed concrete	Sichtbeton m
external bracing	Aussenverstrebung f
external brickwork	Aussenmauerwerk n
fire-clay concrete	Schamotte-Beton m
fittings	(constr) Formstücke n/pl; (mech) Armaturen f/pl, Ausrüstungsgegenstände m/pl
flexural strength test	Biegezugprüfung f
foamed concrete (foumd...)	Schaumbeton m
foamed slag concrete	Hüttenbimsbeton m
foundation soil	Baugrund m
fresh (ly-mixed) concrete	Frischbeton m
gas-formed concrete	Gasbeton m
green concrete	junger Beton
grinding	Feinzerkleinerung f
grinding plant	Mahlwerk n
heat-resistant concrete	hitzbeständiger Beton
heavy-weight concrete	Schwerbeton m
high aluminia cement	Tonerdeschmelzzement m
hollow concrete block	Hohl(beton)stein m
hollow filler tiles	Deckenhohlkörper m/pl
hydraulic construction	Wasserbau m
inherently (in'hiərəntli)	von Natur aus
in-situ concrete	Ortbeton m
intrinsic strength	Eigenfestigkeit f
irregularly shaped slabs	Fliesen f/pl in bizarrer Form
jack	(An)hebevorrichtung f, Winde f, Heber m
kerb (-stone)	Bordstein m
large slab construction method	Grosstafelbauweise f
lifting frame	Hubgerüst n
light-weight concrete	Leichtbeton m

load bearing structures	Flächentragwerke n/pl
long-welded rails	lückenloses Gleis
low-load trailer	Tieflader m
make-up	(constr) Verarbeitung f
manhole ring	Schachtring m
member	Bauteil n, Element n, Glied n
mixer	Mischmaschine f, Mörtelmaschine f; Mischapparat m
mixing plant	Mischanlage f
mixing water	Anmachwasser n
perimeter	Peripherie f, Umkreis m, Umfang m
plane bearing structures	Flächentragwerke n/pl
porous concrete	Porenbeton m
portable silo (... 'sailou)	Fahrsilo m
pouring concrete by chute	Einbringen n des Betons mittels Rutschen
precast	vorgefertigt (Beton)
precast concrete	Betonstein m
precast-concrete industry	Betonsteinindustrie f
precast elements	Fertigteile n/pl
prefabricated	vorgefertigt
pre-fab components	Fertigteile n/pl
prefabrication	Vorfertigung f
prehardening	Vorerhärtung f
prestressed concrete	Spannbeton m
prestressed concrete beam	Spannbetonbalken m
prestressing bed	Spannbett n
pumice concrete	Bimssteinbeton m
quarry ('kwɔri)	Steinbruch m; Grube f, Halde f
raw concrete	Rohbeton m
ready-made concrete	Fertigbeton m
reinforced concrete column	Stahlbetonsäule f
reinforced concrete slab	Spannbetondeckenplatte f
rigidity (ri'dʒiditi)	Steifheit f, Starrheit f
screen	Sieb n, Drahtgitter n, Drahtnetz n
screening	Sieben n
semi-automatic	halbautomatisch

sewage-purification plant	Kläranlage f
sheet piles	Spundwände f/pl
shrinkage ('ʃriŋkidʒ)	Schwinden n (von Leichtbeton)
singly reinforced	schlaff bewehrt
slag concrete	Schlackenbeton m
smooth, to	glätten, polieren, ebnen, nivellieren, planieren
sockets	Muffenpartien f/pl
sooting	Versottung f
space, to	anordnen (in Zwischenräumen), einteilen
standard fire test	Normenbrandversuch m
steel-frame(d) structures	Stahlbauten m/pl
steel shingling	Stahlumwandung f
steel structure	Stahlkonstruktion f
structural elements od. structural units	Bauteile n/pl
supporting structures	Flächentragwerke n/pl
swelling	Quellen n (von Leichtbeton)
tackle, to	angreifen, anpacken, anfassen, sich befassen mit
tendon ('tendən)	Spannglied n
truss (trʌs)	Tragbalken m, Träger m; Hängewerk n; (gen) Bündel n
undisturbed ground	gewachsener Boden
vibrated concrete (vai'breitid...)	Rüttelbeton m
vibration technique	Rütteltechnik f
water gauging (... geidʒiŋ)	Wasserdosierung f
waterlogged soil	wasserdurchlässiges Gebirge
watertightness	Wasserdichtigkeit f
web reinforcement	Stegbewehrung f

GRAMMAR and NOTES

1. Many have done this and are now producing plans for concrete structures that are both attractive and practical.

Gebrauch der Zeiten

Vorbemerkung: Wie das Deutsche besitzt das Englische ein Tempussystem, das zusammengesetzt ist

A. aus den drei Hauptzeiten

Präsens - Präteritum - Futur I
Present - Past - Future

B. aus den drei Perfektzeiten, die eine Rückschau von einem bestimmten Zeitpunkt darstellen:

Perfekt - Plusquamperfekt - Futur II
Present Perfect - Past Perfect - Future Perfect

Jede dieser Zeitstufen hat zwei Aspektformen:

a) die einfache Form (= "einfacher Aspekt"),
b) die Verlaufsform (= "progressiver" bzw. "intensiver Aspekt").

Past Tense - Present Perfect

Verwendung:

Das Past Tense wird verwendet, wenn die Handlung oder der Zustand in der Vergangenheit abgeschlossen wurde. Es steht in Verbindung mit Zeitbestimmungen der Vergangenheit wie: yesterday, the other day, in 1927, allen Zusammensetzungen mit last und ago (last Sunday, three years ago) sowie (auf die Vergangenheit bezüglich) bei just now und nach When...? Das Interesse des Sprechenden richtet sich dabei auf die Handlung selbst, nicht auf deren Ergebnis. Das einfache Präteritum (The Simple Past) bezeichnet a) einmalige, b) aufeinanderfolgende oder c) wiederholte Handlungen der Vergangenheit. Der vergangene Zeitpunkt oder Zeitraum kann durch eine adverbiale Bestimmung oder einen temporalen Nebensatz gekennzeichnet sein oder aus dem Zusammenhang hervorgehen.

a) They moved into the house three months ago.
Vor einem Vierteljahr sind sie (in das Haus) eingezogen.

When were you born? Wann sind Sie geboren?

b) The teacher went to her desk and put down her books.
Die Lehrerin ging zu ihrem Pult und legte ihre Bücher hin.

c) While her husband was abroad, she wrote to him every day.
Solange ihr Mann im Ausland war, schrieb sie ihm täglich.

Anmerkung 1: Auch in Verbindung mit this morning, this afternoon steht das Präteritum im Hinblick auf die vergangene Handlung, wenn die betreffende Tageszeit im Augenblick des Sprechens bereits vorbei ist: What time did you get up this morning? Wann bist du heute morgen aufgestanden? Ebenso findet sich das Präteritum nach today und this week, um die eigentliche Handlung als vergangen zu kennzeichnen:

I had a letter from her today. Ich bekam heute einen Brief von ihr.

Anmerkung 2: Im temporalen Nebensatz steht das Präteritum an Stelle des Konditionals:

He would come as soon as I needed him. Er käme (oder: würde kommen), sobald ich ihn brauchte.

Die Verlaufsform des Präteritums

(The Past Progressive)

Die Verlaufsform des Präteritums bezeichnet den Ablauf einer Tätigkeit zu einem bestimmten Zeitpunkt a) oder Zeitraum b) der Vergangenheit:

a) What were you doing just now? - I was just testing these plugs.
   Was hast du denn eben gemacht? - Ich war gerade dabei, die Zündkerzen auszuprobieren.

b) Last week they were staying with the Bakers.
   Die vorige Woche haben sie sich bei Bakers aufgehalten.

was/were going (to)

Die Verlaufsform des Präteritums von to go bezeichnet als Hilfsverb eine unmittelbar bevorstehende Handlung im Sinne von "wollte gerade; war im Begriff":

What were you going to say? Was wollten Sie gerade sagen?

I was going to ask you a question. Ich wollte Sie gerade etwas fragen.

Auch eine Gewissheit kann hier zum Ausdruck kommen:

He knew what was going to happen. Er wusste, was geschehen würde.

Anmerkung: Die going to-Umschreibung (Präsensform als Futurumschreibung). Die Verlaufsform von to go in Verbindung mit einem Infinitiv (mit to) gilt im heutigen Englisch als beliebte Futurkonstruktion. Sie dient zum Ausdruck konkreter Einzelhandlungen, vor allem mit Bezug auf die nahe Zukunft:
What are they going to do? Was werden (oder: wollen) sie tun?

Das Verhältnis zweier Handlungen im Temporalsatz.

Auch beim Nebeneinander mehrerer Handlungen im Temporalsatz bleiben die ursprünglichen Funktionen der Verlaufsform und der einfachen Form erhalten:
When he was walking through the village, he met an old friend.
Als er durch das Dorf ging, traf er einen alten Freund.
When he met her, he raised his hat. Als er sie traf, zog er den Hut.

Das einfache Perfekt

(The Simple Present Perfect)

Das einfache Perfekt drückt aus, dass die Handlung oder der Zustand bis in die Gegenwart hineinreicht oder ihr Ergebnis bis in die Gegenwart nachwirkt:
Electron beam-heating has long been known.
Die Erwärmung durch Elektronenstrahlbeschuss ist schon lange bekannt.
Prices have gone up. (= Prices are high).
Die Preise sind gestiegen.
An Zeitbestimmungen können sinngemäss nur solche mit dem Present Perfect verbunden werden, die eine Beziehung zur Gegenwart zum Ausdruck bringen wie till now, up to the present, so far, already, (not) yet, ever, never, lately "in letzter Zeit, kürzlich", now, just, these days (~ years).
Ebenso kann das einfache Perfekt für wiederholte Handlungen stehen:
He has always treated me decently.
Er hat mich immer anständig behandelt.
Anmerkung: Bei recently "vor kurzem, kürzlich" findet sich das Perfekt (= Ergebnis) gelegentlich neben dem Präteritum (= Handlung):

Have you seen a good film recently?
Haben Sie in letzter Zeit einen guten Film gesehen?
I saw her only recently. Ich habe sie erst vor kurzem gesehen.

Das einfache Perfekt steht auch für eine in der Vergangenheit begonnene Handlung, die im Augenblick des Sprechens noch andauert. Dabei wird entweder der Beginn der Handlung durch since oder ihre bisherige Dauer durch for (="seit") bezeichnet. Das Deutsche verwendet hier in der Regel das Präsens, meist in Verbindung mit "schon":

He has lived in this house since 1960.
Er wohnt in diesem Hause schon seit 1960.
He has worn that coat for three years.
Er trägt diesen Mantel schon seit drei Jahren.

Hierher gehören vor allem auch Verben, die die Vorstellung eines Verlaufs in der Regel nicht zulassen:

He has been here for six months.
Er ist schon seit einem halben Jahr hier.
I haven't met him since. Ich habe ihn seitdem nicht getroffen.

Die Verlaufsform des Perfekts

(The Present Perfect Progressive)

Durch die Verlaufsform des Perfekts wird in der Regel eine in der Vergangenheit begonnene Tätigkeit in ihrem gesamten Ablauf (bis zur Gegenwart) in das Blickfeld gerückt. Hierbei ergeben sich drei Möglichkeiten:

a) Die Tätigkeit dauert im Augenblick des Sprechens weiter an. Der Zeitraum wird durch since oder for gekennzeichnet. Im Deutschen steht gewöhnlich das Präsens in Verbindung mit "schon":

How long have you been learning English?
Wie lange lernen Sie schon Englisch?
He has been working at that factory for about twenty years.
Er arbeitet (schon) seit etwa zwanzig Jahren in dieser Fabrik.

b) Die Verlaufsform des Perfekts steht auch, wenn die Tätigkeit unmittelbar (oder doch verhältnismässig kurze Zeit) vor dem Sprechen beendet worden ist:

I have (just) been reading a most interesting article.
Ich habe gerade einen hochinteressanten Artikel gelesen.
What have you been doing while I was away?
Was hast du gemacht, während ich weg war?
I have been telephoning all the morning.
Ich habe den ganzen Morgen telefoniert.

c) Auch die wiederholte Ausführung einer Tätigkeit (während eines bis an die Gegenwart heranreichenden Zeitraumes) kann in der Verlaufsform des Perfekts ausgedrückt werden:

I have been paying a lot of bills by cheque.
Ich habe eine Menge Rechnungen mit Scheck bezahlt.
She has been going there every summer for the last forty years.
Während der letzten vierzig Jahre ist sie jeden Sommer hingefahren.

2. Anmerkungen zum Text und weitere wichtige Ausdrücke:

SiF_4 treatment - SiF_4 Behandlung f, Okratierung f (des Betons gegen angreifende Medien, gegen Säuren mit Siliziumtetrafluorid)

test performed on fragments - Bruchstückprüfung f

impingement angle of rain - Auftreffwinkel m des Regens

the setting of the concrete - Abbinden n, Erstarren n

the driving shield is not conceived for any kind of soil - der Vortriebsschild ist nicht für jede Bodenart gedacht

tank formed of concrete staves - Betondaubenbehälter m, Betondaubensilo m

pre-fabricated slab consisting of pebbles embedded in cement - Fertigfliese f aus kleinen, in Zement eingelassenen Kieselsteinen

prefabricated construction using ready-made reinforced concrete units - Grosstafelbauweise f

sensitiveness to frost - Frostempfindlichkeit f

sound insulation (sound and fire protection) - Schallschutz m (Schall- und Brandschutz)

after fastening the steel shingles - nach dem Zusammenbau

too friable a sand - zu weicher Sand

under flexural strength - biegebeansprucht

EXERCISES

1. Insert Past Tense or Present Perfect where needed:

1) He (to study) electrical engineering at the Technical University for the past three years. 2) They (to be) friends for some ten years. 3) The need for more radio stations (to force) research and development into higher frequencies. 4) Before 1936 most engineers (to regard) the radio valve as a means of obtaining amplification of near-sinusoidal waveform. 5) Many new houses (to be) built here last year. 6) We (to know) them for a long time. 7) The sun was just setting when we (to reach) home. 8) Recently I (to spend) a week-end at the sea-side. 9) The students (to experiment) on these electrical devices all day long.

2. Translate into German:

1) These students have never visited a nuclear power station. 2) Units of 200 MW were being manufactured early in 1958. 3) I heard the news an hour ago. 4) Thus far (Up to now) the flaming arcs and the magnetic lamp have been used to a limited extent only. 5) In 1927 the first photoelectric cell was invented. 6) We were playing tennis in the garden when he phoned. 7) New alloys of copper have been introduced from time to time to meet certain advances in technology. 8) This device has been on the market for three years. 9) We listened to the wireless last night. 10) He has been living in Vancouver since 1972.

3. Translate into English:

1) Ich habe dich diese Woche noch nicht gesehen. 2) Als Georg heimkam, war sein Bruder gerade dabei, ein Fernsehgerät zu reparieren. 3) Ich warte (schon) seit drei Uhr auf ihn. 4) Wir haben gestern abend Rundfunk gehört. 5) Ich habe diese Nachricht vor drei Stunden gehört. 6) Diese Studenten haben noch nie ein Atomkraftwerk besichtigt. 7) Im Jahre 1927 wurde die Photozelle erfunden. 8) Immer wieder werden neue Kupferlegierungen eingesetzt, wenn bestimmte Fortschritte in der technischen Entwicklung dies erfordern.

ARCHITECTURE

(American)

Every building project involves a process of seven stages:

1) formulation of the demand,
2) arrangement of financing,
3) design,
4) supervision of construction,
5) direction of construction,
6) erection,
7) procurement of building materials.

The primary functions of the architect in the building process comprise design and supervision of construction. In the stage of design, the architect works with the owner to determine the physical, social, and economic requirements of the project. After careful study of alternative possibilities, he creates the optimal solution which will best satisfy these conditions. This solution is then set forth in explicit working drawings and specifications for the guidance of construction operations. In the stage of supervision, the architect facilitates the progress of the erection of the building and protects the owner by checking the accuracy of the work. In addition to these primary responsibilities, however, the other stages of the process affect the result to a profound degree, and so the architect must also take them into close account. Thus, a skilled architect acts as a leader and coordinator for the whole building process to the end that the quality of buildings will be the best attainable under the given conditions. This element of quality depends upon the successful achievement and integration of efficient usefulness, a safe, durable, and economic structure, and an attractive aesthetic expression.

If an architect is to be able to perform these functions effectivel in an increasingly complex civilization, he must have to as high a degree as possible wide recources of knowledge, skills, and abilities. Ideally, he must understand the full range of human needs and aspirations; he must combine the keen analytical mind of the technician with the creative imagination of the artist and the administrative acumen of the man of business; he must be able to work harmoniously with clients, his own staff, and with others in the building industry; and he will find indispensable the traits of integrity, responsibility, initiative, perseverance, and leadership. For those who can meet these requirements, the profession of architecture can afford unexcelled opportunities for social usefulness and personal satisfaction.

The aim of architectural education is, therefore, to train prospective architects. Because such training grows as long as experience teaches, it is a continuing process which includes all stages of formal schooling, the period of preliminary practical experience, and practice itself.

Virtually all architecture deals with the enclosure of space for human use. Almost always a building calls for a number of areas different in size and shape and adapted to varied purposes. These must be so organized that they provide adequate accommodation and convenient access from one to another. The plan of a structure, always the first consideration of an architect, is the resolution of these different purposes into an organization of spaces that will fulfill the intent of the building. Good planning guides the visitor to his destination in the structure and impresses him, perhaps subconsciously, by visibly relating the several units of the edifice. Conversely, a bad plan results in inconvenience, waste, and visual confusion.

Furthermore, architecture must be well built; it should have such permanence as the problem demands and as the materials chosen may allow. Hence, the raw materials of architecture - stone, brick, wood, steel, or glass - in part govern the forms and are expressed in them. Thus, stone lends itself to post-and-lintel or to vaulted construction, but not to cantilevered construction; on the other hand, steel, and reinforced concrete have vast possibilities as cantilevers. Or again, if stone is used in the post-and-lintel system, since the possible length of a stone beam is limited, the supports or columns must be fairly closely spaced and therefore large open interiors are impossible. With steel, however, the beams may be longer, the supports more widely spaced and themselves smaller, so that larger unencumbered areas are possible.

Finally, architecture must do more than meet the physical requirements of strength and space; ist must also content the spirit of man. It should crystallize in visual form the problem which it solves, and convey through that form the ideals and aspirations of man at the time and in the place of its building. The successive historic styles are incarnations of the time spirit.

Ancestry and Character of the International Style. - Every major style in the history of architecture was born because there appeared new problems for architecture to solve, new building materials, or new methods or principles of construction. Before the 20th century began, all three of these prerequisites had been fulfilled. The growth of industrialism, new means of transportation and communication, new concepts of medicine or of education gave rise to problems unfaced by previous generations. Structural metals, concrete, glass, and fabricated materials offered fresh possibilities in design. Metal and concrete made it possible to exploit the cantilever as never before. The application of machines in the controlled conditions of factories to the production of materials, and sometimes to whole sections of buildings, made obsolete the older styles based on handicraft methods.

The multistoried building was called into being by the desire of American businessmen engaged in the same type of enterprise to be close to their fellows. It could not exist without a metal frame to hold both floors and walls. It would not have been created without the elevator to provide vertical transportation; from the 1850's elevators were installed. In 1882, Leroy S. Buffington in Minneapolis devised a method of supporting the walls and floors of multistoried buildings on a metal frame. The Home Insurance Building, Chicago

(1883-1885), by William L. Jenney, first applied this idea. Louis Sullivan in Chicago, influenced by Richardson's later work, developed the _functional theory of architecture_. According to this theory, any problem in architecture contained the germ of its own solution; the duty of the architect was so fully to understand the problem that the solution of both its utilitarian and its expressive aspects became apparant, neither of which could be met by historic styles. The Wainwright Building, St. Louis (1890-1891), came close to a functional expression of the purpose, structure, materials, and nature of a skyscraper. All the great styles of the past were based on plans suited to their functions, on sound building with the chosen materials, and on expression of both function and material in design; in other words, on commodity, firmness, and delight.

QUESTIONS

1) What does every building project involve?
2) What do primary functions of the architect in the building process comprise?
3) What is the aim of architectural education?
4) What do we call "raw materials of architecture"?
5) What possibilities have steel and reinforced concrete as cantilevers?
6) What do we understand by "International Style"?
7) What is meant by "multistoried buildings"?
8) Who developed the functional theory of architecture?
9) On what were based all the great styles of the past?
10) What do you understand by "freehold flats"?

IMPORTANT TERMS

acumen (ə'kjuːmen)	-	Scharfsinn m
ancestry	-	Abstammung f; Vorfahren pl, Ahnen pl
ancetry research	-	Ahnenforschung f
asbestos cement slab	-	Asbestzementplatte f
cantilever ('kæntiliːvə)	-	Ausleger m, freitragender Arm, Konsole f
cantilevered	-	freischwebend

cast stone slab	-	Beton (werkstein) platte f
cavity	-	(constr) Aussparung f
commodity	-	Nützlichkeit f, Nutzen m
consortium *(kən'sɔːtjəm)*	-	Arbeitsgemeinschaft f
crushed blast-furnace slag	-	Hochofenstückschlacke f
deflection	-	(constr) Durchbiegung f
design	-	Planung f, Gestaltung f; Projekt n; Konstruktion f, Konstruktionszeichnung f; Bauart f, Modell n, Typ m
edifice	-	Gebäude n, Bau m,
encumber, to *(in'kʌmbə)*	-	behindern, belasten, beschweren
error of conception	-	Planungsfehler m
facing units	-	Fassadenelemente n/pl
firmness	-	Festigkeit f, Beständigkeit f, Entschlossenheit f
foamed plastic	-	Schaumkunststoff m
freehold flat	-	Eigentumswohnung f
germ *(dʒəːm)*	-	Keim m
handicraft	-	Handwerk n, Handarbeit f, Handfertigkeit f
heat insulation	-	Wärmeschutz m
incarnation	-	Verkörperung f, Inbegriff m
insulating slab	-	Isolierplatte f, Dämmplatte f
intent	-	Vorhaben n, Vorsatz m; Zweck m, Plan m, Ziel n
internal work	-	Innenausbau m
lateral underpacking	-	seitliches Unterstopfen
lintel *('lintl)*	-	Oberbalken m, Oberschwelle f
metal framework	-	Metallgerippe n
moisture content	-	Feuchtigkeitsgehalt m
multi-storied building	-	Hochhaus n
multi-storey apartment house	-	Wohnhochhaus n
non-reinforced slab	-	unbewehrte Platte
obsolete *('ɔbsəliːt)*	-	veraltet, ausser Gebrauch
perseverance *(,pəːsi'viərəns)*	-	Ausdauer f, Beharrlichkeit f
post	-	(constr) Pfosten m, Pfahl m
prerequisite	-	Voraussetzung f, Vorbedingung f

recess (ri'ses)	-	Einbuchtung f (Innenarchitektur)
ribbed floor	-	Rippendecke f
sand-blasting	-	Sandstrahlbehandlung f
shale	-	Schieferton m
single-family house	-	Einfamilienhaus n
slab	-	Platte f, Fliese f, Tafel f
soundproof	-	schalldicht
storage time	-	(constr) Vorlagerung f; (electron) Speicherdauer f, (gen) Lagerdauer f, Lagerzeit f
strutting (strʌtiŋ)	-	Abspriessung f, Absteifung f
surface construction	-	Hochbau m
thermal insulation	-	Wärmeschutz m
trait	-	Eigenschaft f, Merkmal n
vaulted (vɔ:ltid)	-	gewölbt
volume weight	-	Raumgewicht n

GRAMMAR and NOTES

1. Before the 20th century began, all three of these prerequisites had been fulfilled.

Das Plusquamperfekt

Vorvergangenheit | Past Perfect

Das Plusquamperfekt verhält sich zum Präteritum wie das Perfekt zum Präsens. Es bezeichnet eine Handlung, die zu einem näher bestimmten Zeitpunkt der Vergangenheit bereits vollzogen wurde.

A. Das einfache Plusquamperfekt
(The Simple Past Perfect)

Das einfache Plusquamperfekt wird verwendet

a) für Handlungen, die zu einem bestimmten Zeitpunkt der Vergangenheit bereits abgeschlossen waren. Der Zeitpunkt, auf den die Handlung bezogen ist, wird dabei entweder durch eine zweite Handlung (im Präteritum) gekennzeichnet oder aber durch eine entsprechende adverbiale Zeitbestimmung wie by that time:

We thanked him for what he had done. Wir dankten ihm für das, was er getan hatte.

She had just reached home when it began to rain. Sie war gerade zu Hause angekommen, als es zu regnen anfing.

Before they had gone very far, they found that they had lost their way. Ehe sie noch sehr weit gekommen waren, bemerkten sie, dass sie den Weg verloren hatten.

By that time it had stopped raining. Inzwischen hatte zu regnen es aufgehört.

b) für Handlungen oder Zustände, die vor einem bestimmten Zeitpunkt der Vergangenheit begonnen wurden, aber bis zu ihm oder über ihn hinaus andauerten. Wie beim Present Perfect wird hier in der Regel entweder der Beginn (durch since) oder die bisherige Dauer (durch for) angegeben. Im Deutschen steht gewöhnlich das Präteritum mit "schon":

By December 1st last year he had lived in this house for twenty years. Am 1. Dezember des vorigen Jahres wohnte er schon 20 Jahre in diesem Hause.

Hierher gehören vor allem wieder Verben, die im allgemeinen nicht als Tätigkeiten empfunden werden:

I had known him for years before we were introduced to each other. Ich kannte ihn schon jahrelang, ehe wir einander vorgestellt wurden.

B. Die Verlaufsform des Plusquamperfekts

(The Past Perfect Progressive)

Durch die Verlaufsform des Plusquamperfekts wird in der Regel eine weiter zurückliegende Tätigkeit in ihrem gesamten Ablauf bis zu einem näher bestimmten Zeitpunkt in der Vergangenheit in das Blickfeld gerückt. Sie entspricht in ihren Anwendungen, nur weiter in die Vergangenheit gerückt, der des Perfekts.

a) Die Tätigkeit dauert weiter an (im Deutschen steht meist das Präteritum mit "schon"):

How long had you been learning English then?
Wie lange lernten Sie damals schon Englisch?
He had been waiting (for) twenty minutes before she arrived.
Er wartete schon zwanzig Minuten, ehe sie ankam.
He had been living in that house ever since he came here.
Er wohnte schon immer in diesem Hause, seit er hierher gekommen war.

b) Die Tätigkeit ist kurz vor einem bestimmten Zeitpunkt in der Vergangenheit beendet worden:

I had just been reading a most interesting article.
Ich hatte gerade einen sehr interessanten Artikel gelesen.

Die Tätigkeit kann auch wiederholt vor sich gegangen sein:
He had been having headaches constantly for the last year.
Er hatte während des letzten Jahres dauernd Kopfschmerzen gehabt.

2. CONSTRUCTIONAL ENGINEERING

Steel structures

The symbols recommended under this heading are available for use with other metal structures and with timber.

Term	Symbol
Dimensions	
length or span	l,L
height	h,H
depth	d,D
breadth	b,B
thickness	t
radius	r,R
diameter	d,D
area	A...a
volume	V...v
distance from centroid or neutral axis	y
rise of arch or sag of cable	h,d
eccentricity	e
pitch	s...p

Term	Symbol
Properties of sections; material constants	
moment of inertia; second moment of area	I
radius of gyration	k, r
modulus of section	Z
moment of resistance	M_r
plastic modulus	S
flexural stiffness of a member, e.g. beam, column or strut (EI/l)	K
flexural rigidity of a plate or slab	D
shape factor	λ
modulus of elasticity (direct) or Young's modulus	E
modular ratio, steel to concrete (E_s/E_c)	m
modulus of rigidity, or shear modulus	G
modulus of rupture	R
bulk modulus (modulus of compressibility)	K
Poisson's ratio	$\nu \ldots \sigma$
torsion constant	J
External loads and pressures	
applied load	P, W
pressure, intensity of applied load	p, w
vertical reaction	V
horizontal reaction	H
resultant reaction	R
Forces and moments	
direct force	F
shear force	Q
torque	T
bending moment	M
force in member/load on structure	u
Stresses	
permissible tensile stress	p_t
calculated tensile stress	f_t
permissible compressive stress	p_c
calculated compressive stress	f_c
permissible shear stress	p_q
calculated shear stress	f_q
permissible bearing stress	p_b
calculated bearing stress	f_b
permissible bending stress in tension	p_{bt}
calculated bending stress in tension	f_{bt}
permissible bending stress in compression	p_{bc}
calculated bending stress in compression	f_{bc}
tensile strength*	f_u
yield stress in tension	f_y, Y
equivalent or reference stress	f_e

Term	Symbol
Strains and displacements	
strain, linear	ϵ
strain, shear	ϕ
elongation	δl
slope	i, θ
angular displacement	θ
deflexion	y, δ, Δ

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*This term replaces 'ultimate tensile stress', the use of which is not now recommended.

CONCRETE STRUCTURES

Dimensions	
length or span	l, L
height	h
depth	d, D
effective depth from compressive face to tensile reinforcement	d_1
depth from compressive face to neutral axis	$n_1 d_1, d_n$
depth from compressive face to compressive reinforcement	d_2
breadth	b
thickness	t
radius	R
diameter	D
lever arm	$a_1 d_1, l_a, a$
eccentricity	e
pitch	s
sum of perimeters of tensile reinforcement	o
area of column or beam	A
area of concrete	A_c
area of steel	A_s
in tension	A_{st}
in compression	A_{sc}
area of web or shear reinforcement	A_w
equivalent area of helical or binding reinforcement (volume of helix/length of column)	A_b
area of concrete in column core	A_k
Properties of sections and material constants	
moment of inertia; second moment of area	I
radius of gyration	k
modulus of section	Z
moment of resistance in bending	M_r

Term	Symbol
flexural stiffness of a member (I/l)	K
of a beam	K_b
of an upper column	K_u
of a lower column	K_l
percentage of reinforcement	r
equivalent area of section in terms of concrete	A_e
modulus of elasticity (direct) or Young's modulus	E
of concrete	E_c
of steel	E_s
modular ratio (E_s/E_c)	m
modulus of rigidity, or shear modulus	G
bulk modulus (modulus of compressibility)	K
Poisson's ratio	$\nu \ldots \sigma$
External loads and pressures	
load or weight, concentrated or total	W
load or weight, distributed (divided by length or area)	w
vertical reaction	V
horizontal reaction	H
resultant reaction	R
Forces and moments	
direct force	F
in concrete	F_c
in compression	F_{cc}
in tension	F_{ct}
in steel	F_s
in compression	F_{sc}
in tension	F_{st}
permissible force	P
in concrete	P_c
in steel	P_s
shear force	Q
bending moment	M
fixed end moment	M_e
Stresses	
direct stress	f
in concrete	f_c
in compression	f_{cc}
in tension	f_{ct}
in steel	f_s
in compression	f_{sc}
in tension	f_{st}
permissible stress	p
in concrete	p_c
in compression	p_{cc}
in compression in bending	p_{cb}
in steel	p_s
in compression	p_{sc}
in tension	p_{st}

Term	Symbol
concrete strength	
cube strength	u
equivalent cube strength	u_e
cylinder strength	u_{cyl}
preliminary cube strength	u_p
works cube strength	u_w
ultimate compressive strength in bending	u_b
modulus of rupture	R
steel strength	
ultimate stress	f_u
proof stress	f_p
yield stress	f_y
shear stress	q

Strains and displacements

direct strain	ϵ
in concrete	ϵ_c
in steel	ϵ_s
(with further modifications of subscripts as for direct stress if required)	
shear strain	ϕ
deflexion	δ, Δ
angle of rotation	θ

EXERCISES

1. Supply the proper tense of the verb in parentheses:

1) He had been reading his mail when we (arrive). 2) If it doesn't rain, we (eat) our lunch on the patio. 3) Joanne (lie) on the floor for several hours last night listening to her records. 4) George (work) in that same firm for ten years. 5) At the present time there (be) three more films to be shown. 6) Mr. Davis (teach) in their school since January. 7) The twins (swim) across the lake last summer. 8) If you hurry to the station, you (see) her before she departs. 9) Marie (listen) to you for an hour and now she is tired. 10) Last year their films (win) five awards out of fifteen. 11) For the last two years her son (study) in Paris. 12) Robert (drink) his coffee and left. 13) It (rain) yesterday after it (be) dry for several months. 14) He (come) at five o' clock as we (arrange). 15) He (admit) that he never (believe) in her ability. 16) The fire (reach) the next building before the firemen (come). 17) He (take) the position after they (offer) it to him several times. 18) In the nineteenth century coal (replace) water, which up to that time (be) the chief source of power. 19) Low water, which previously (interrupt) the work of mills on a stream, (not to stop) mills operated by coal.

2. Translate into English:

1) Eine erste höhere Stufe erreichte die Technik, als der Mensch die Naturprodukte für seinen Gebrauch zweckentsprechend zu bearbeiten suchte. 2) Als um die Jahrhundertwende die industrielle Anwendung der Elektrizität einen raschen Aufstieg nahm, fehlte es an elektrischen Isolierstoffen. 3) Der unermüdliche Erfinder wiederholte so oft seine Versuche, bis sie glückten. 4) Seitdem seine Ergebnisse veröffentlicht worden waren, suchten die Forscher das Aluminium nach seiner Methode zu gewinnen. 5) Wenn man ein Stück Bernstein reibt, zieht er kleine Gegenstände an.

POWER and MECHANICAL ENGINEERING

(American)

Internal-combustion Engines. - The engines of practically all mechanically propelled road vehicles, motorcycles, airplanes, farm tractors, motor boats, and mobile industrial units belong to that class of prime movers known as heat engines, and to the subdivision thereof which has been generally referred to as "internal-combustion" engines.

Combustion engines may be divided into types according to the duration of the cycle on which they operate, in terms of piston strokes. By a cycle is meant the succession of operations in the engine cylinder which constantly repeats itself. The great majority of modern automotive engines operate on the four-stroke cycle which is completed in four strokes of the piston, or during two revolutions of the crankshaft. Engines are also being built to operate on a cycle which is completed in two piston strokes. In this cycle a combustible gaseous mixture is compressed in the cylinder during the outward stroke of the piston, and burned and allowed to expand during the following inward stroke. Evacuation of the products of combustion and admission of a new charge take place during the latter part of the expansion, and the early part of the compression stroke. Since there is no separate exhaust stroke, the burnt gases cannot be expelled from the cylinder by a pumping action of the piston therein; they must be blown out, by either fresh air or combustible mixture, under pressure, a process known as scavenging. Two-stroke engines with scavenging by combustible mixture are used only in small units, and generally only in applications where the operation is quite intermittent. Their chief advantage is low first cost; their disadvantages are low fuel economy and lack of flexibility. A few engines have been built to operate on a six-stroke cycle, which has certain advantages where fuel of low volatility is to be used. Four of the six strokes of this cycle are used for the same operations as in the four-stroke cycle; during the remaining two strokes the combustible mixture is retained in the cylinder without being ignited, to give the fuel a better chance to vaporize and to diffuse uniformly throughout the air charge.

The four-stroke cycle comprises the following four phases or operations, which succeed one another in the order in which they are given:

Admission of the charge to the cylinder.
Compression of the charge.
Combustion of the charge (which includes its ignition and expansion).
Expulsion of the products of combustion.

Diesel Engines. - A diesel engine is a machine which produces power by burning oil in a body of air which has been squeezed to a high pressure by a moving piston. Since it is a machine that produces power, it is called an engine, and since the burning or combustion takes place within the engine itself, it is called an internal-combustion engine. A steam engine uses steam made by burning fuel outside the engine. That is external combustion.

A diesel engine is that type of internal-combustion engine which injects fuel oil in a finely divided state into a cylinder within which air has been compressed to a high pressure and temperature. The temperature of the air is high enough to ignite the particles of the injected fuel; no other means are used for ignition. Because of this method of ignition, diesel engines are sometimes called compression-ignition engines. This sets them apart from other internal-combustion engines called spark-ignition engines. These latter engines use gasoline or gas as fuel, and the mixture of fuel and air is ignited by an electric spark. Why, then, do we call this compression-ignition engine by the name "diesel"? Simply because a man whose name was Rudolf Diesel originated in Germany and obtained patents in 1892 on a high-compression, self-ignition engine originally intended to burn powdered coal.

Advantages of Diesel Engines.

1. Small consumption of fuel. The diesel engine is one of the most highly efficient heat engines; that is, it gets more power out of the fuel it burns than any other ordinary prime mover, except the largest and most efficient steam turbines. Its fuel consumption is much less than that of a gasoline engine. It is an engine of high economy.

2. Cheap fuel.

3. Economy at light loads. The diesel engine is not only efficient when it is fully loaded, but also when it is only partly loaded.

4. Greater safety. Diesel fuel is non-explosive and is far less inflammable than gasoline. This feature, alone, makes the diesel attractive in the motorboat field.

5. Economy in small sizes. In great contrast to a steam-power plant, a small diesel engine has nearly as good an economy as a large one. This makes it possible to build an efficient power plant just large enough to meet present needs, and to enlarge it with additional units as the load grows. At all stages of growth, the efficiency is high.

6. Sustained economy in service. Again in contrast to a steam-power plant, diesel efficiency falls off little during thousands of hours of use between overhauls.

7. Independence of water supply. A diesel engine requires little water, and can be successfully used in the most arid regions.

8. Lightness and compactness. The diesel engine is a complete power plant in itself; it can be made light in weight and takes up a small amount of space. It is therefore well suited to portable and mobile installations.

9. Quick starting. A cold diesel engine can be started instantly and made to carry its full load in a few minutes. It is therefore ideal for supplying emergency power.

10. Easily reversible. By adding an extra set of cams, a diesel engine can be made to run at full power in either direction. This is important in marine applications.

11. Economy in labor. No fireroom force is needed.

12. Freedom from nuisance. There are no ashes to be disposed of, no noisy and dusty coal-handling and pulverizing equipment to maintain, no smoke, and noise can be easily eliminated.

GASOLINE ENGINES.

Fundamentals of the Automobile. - Basically, the automobile consists of four components. These are:

1. The engine.
2. The framework, or support for the engine and wheels.
3. The power train, or mechanism that transmits the power from the engine to the wheels.
4. The body.

To these may be added a fifth component, the car-body accessories: the heater, lights, radio, and other devices that contribute to the convenience and comfort of the driver.

The engine is the source of power that makes the wheels go around and the car move. It is usually referred to as an internal-combustion engine because gasoline is burned within its cylinders or combustion chambers. This burning, or combustion, takes place at such high speed as to be termed an "explosion"; the high pressure thus created causes a shaft to turn or rotate. This rotary motion is transmitted to the car wheels by the power train so that the wheels rotate and the car moves. The activities that take place in the engine cylinder can be divided into four stages, or strokes. The four strokes are: intake, compression, power and exhaust.

Components of Electric System. - The electric system consists of the storage battery, cranking motor, generator, regulator, ignition distributor, coil, and spark plugs as well as the wires and switches that connect these various units. Lights, radio, heater, indicating gauges, and other electrically operated devices, while a part of the electric system, are usually considered as accessory devices, since they are not absolutely necessary to the operation of the car.

Power Train. - The power train consists of a series of gears and shafts, which mechanically connect the engine shaft with the car wheels, and contains a clutch, a transmission or change gears, a propeller shaft, and the final drive.

BOILERS. - The function of the boiler is to furnish a supply of steam at the required pressure, of quality as nearly dry as possible. There are many different types of boilers, and in the selection of one to work under given conditions, attention must be paid to

a) the suitability of the design for safely carrying the proposed steam pressure.

b) The efficiency with which the potential energy of the coal or other fuel is converted into heat in the steam.

c) Accessibility, both externally and internally.

d) Space occupied.

e) Speed with which steam can be raised, starting with cold water and fires out.

Boilers are either fire-tube or water-tube. In *fire-tube boilers*, the furnace gases are led through tubes around which water circulates. In *water-tube boilers*, the water occupies the interior of the tubes and the gases pass over them externally. In general, water-tube boilers are more suitable than fire-tube boilers for the generation of steam at very high pressures, and for the fulfillment of condition (e) above. The efficiency in well-designed boilers of both types is about the same. Water-tube boilers take up less space than fire-tube boilers of the same power.

STEAM ENGINES. - Steam is generated from water by the application of heat. When an open vessel is used, the steam is given off at the same pressure as that of the atmosphere, but a much higher pressure may be secured by generating steam in a closed vessel. Steam may be used for the production of work by allowing it to push a piston to and fro in a cylinder; or, by causing it to discharge against vanes formed round the circumference of a wheel, thus producing rotation. Steam engines having pistons working in cylinders are generally employed to give a motion of rotation to a shaft. This result is effected by means of a mechanism called the crank and connecting rod. A steam engine has a cylinder provided with a slide valve. The steam enters the cylinder and presses on the piston, forcing it back; the slide valve then cuts off the steam supply and the steam expands, forcing the piston back still further and compressing the steam on the other side of the piston. The steam now enters the other side of the cylinder and the process continues in the opposite direction, the expanded steam being expelled from the cylinder. The space between the cylinder cover and the piston in its extreme position is called the clearance volume. In a simple slide-valve engine the expansion of the steam starts and finishes in the same cylinder. A better design is a four-valve compound engine fitted with a condenser.

STEAM TURBINES.

Types and Definitions. - A steam turbine may be defined as a form of heat engine in which the energy of the steam is transformed into kinetic energy by means of expansion through nozzles, and the kinetic energy of the resulting jet is in turn converted into force doing work on rings of blading mounted on a rotating part. The usual turbine consits of four fundamental parts: the rotor which carries the blades or buckets; the stator consisting of cylinder and casing, which are often combined and within which the rotor turns; the nozzles or flow passages for the steam, which are generally fixed to the inside of the cylinder; and the frame or base for supporting both the stator and the rotor, the latter being carried in bearings. Cylinder, casing, and frame are often combined, particularly in small turbines. Accessories necessary for the successful continuous commercial operation are a controlling or governing system for adjusting the energy supply to the turbine to suit the load to be carried and for maintaining constant speed, a lubricating system, piping for steam supply and exhaust, and (for economical power generation in large quantities) a condensing system.

Classifications of Steam Turbines. - Steam turbines may be classified in the following ways:

A. With respect to form of steam passage between the blades:
   - a. Impulse
      1. Simple or single-stage
      2. Velocity-stage, Curtis
      3. Pressure-stage, Rateau
      4. Combination pressure-and velocity-stage.
   - b. Reaction, Parsons
   - c. Combination impulse and reaction

B. With respect to general arrangement of flow:
   - a. Single-flow
   - b. Double-flow
   - c. Compound, two-or three-cylinder, cross-or tandem-connected
   - d. Divided-flow

C. With respect to direction of steam flow relative to plane of rotation:
   - a. Axial-flow
   - b. Radial-flow
   - c. Tangential-flow

D. With respect to repetition of steam flow through blades:
   - a. Single-pass
   - b. Re-entry or repeated flow

E. With respect to rotational speed:
   - a. For 60-cycle generators
   - b. For 50-cycle generators (European practice)
   - c. For 25-cycle generators
   - d. For geared units and for direct-connected or electric-drive marine units, no especial speed requirements

F. With respect to relative motion of rotor or rotors:
   - a. Single-motion
   - b. Double-motion

G. With respect to steam and exhaust conditions:
   - a. High-pressure condensing
   - b. High-pressure noncondensing

c. Back-pressure
d. Superposed or topping
e. Mixed-pressure
f. Regenerative
g. Extraction, single
h. Extraction, double
i. Reheating or resuperheating
j. Low-pressure

GAS TURBINE

The turbine is a major component common to the gas turbine-propeller engine, and to the thermal jet engine. In the gas turbine-propeller engine the turbine must develop the shaft power for driving the air compressor, propeller, and the auxiliaries. In the thermal jet engine, however, it is required to furnish only sufficient power to drive the air compressor and the auxiliaries. It should be noted that, in general, gas turbine-propeller engines are designed to deliver auxiliary jet thrust from the exhaust gases in addition to the propeller thrust, the usual proportions being 80 per cent propeller thrust and 20 per cent auxiliary thrust. Particularly helpful to the development of turbines which operate with highly heated gases are the experiences gathered in the development of turbo-superchargers and also steam turbines for high-pressure and high-temperature applications. In many respects the turbine for gas turbine-propeller engines or turbo-jet engines is quite similar to the conventional steam turbine, the major difference being in the metallurgy, the means provided for cooling the bearings and highly stressed parts, and in the constructional features to safeguard against thermal distortion. The basic theory underlying their design and the evaluation of their operating characteristics is identical with that for steam turbines.

The principal requirements are: a) light weight; b) small frontal area; c) high efficiency; d) ability to operate for sustained periods at high temperature; and e) reliability and serviceability.

HYDRAULIC TURBINES

Power may be developed from water by three fundamental processes: by action of its weight, of its pressure, or of its velocity; or by a combination of any or all three. In modern practice the Pelton or impulse wheel is the only type which obtains power by a single process, the action of one or more high-velocity jets. This type of wheel is usually found in high-head developments.

Types of Hydraulic Turbines. - Hydraulic turbines may be grouped in two general classes: the impulse type which utilizes the kinetic energy of a high-velocity jet which acts upon only a small part of the circumference at any instant, and the reaction type which develops power from the combined action of pressure and velocity of the water that completely fills the runner and water passages. The reaction group is divided into two general types: the Francis, sometimes called the reaction type, and the propeller type. The propeller class is also further subdivided into the fixed-blade or propeller type, and the adjustable-blade type of which the Kaplan is representative.

QUESTIONS

1) What do we understand by "internal-combustion engines"?
2) What is meant by a cycle?
3) What is the chief disadvantage of two-stroke engines?
4) What operations does a four-stroke cycle comprise?
5) What is a diesel engine?
6) How are diesel engines sometimes called?
7) What do we mean by "spark-ignition engine"?
8) What are the chief advantages of diesel engines?
9) What are the fundamentals of an automobile?
10) What is the function of a boiler?
11) Why have most boilers economizers?
12) Why are steam turbines used to change heat into mechanical energy on a large scale?

IMPORTANT TERMS

accessories	Zubehör n
back-pressure turbine	Gegendruckturbine f, Gegendruckdampfturbine f
base	(mech) Grundplatte f, Fundament n, Unterlage f, Sockel m
bent-tube boiler	Steilrohrkessel m
blade	(mech) Schaufel f, Flügel m, Blatt n
blading	(mech) Beschaufelung f
casing	(mech) Gehäuse n
clearance volume	(mech) Kompressionsraum m, Verdichtungsraum m, Totraum m, Zylinderhöhe f
combustible mixture	Kraftstoffgemisch n
combustion chamber	Brennkammer f, Verbrennungskammer f
compound engine	Verbundmaschine f, Kompoundmaschine f, Woolfsche Dampfmaschine f
compression-ignition engine	Dieselmotor m, Motor m mit Eigenzündung oder Verdichtungszündung
connecting rod	Pleuel m, Pleuelstange f
consumption of fuel	Kraftstoffverbrauch m
crank (kræŋk)	(mech) Kurbel f, Kurbelkröpfung f
cranking motor	(mech) Anlasser m, Anlassmotor m, Starter m
crankshaft	Kurbelwelle f
cross drum	Quertrommel f
crosshead	(mech) Kreuzkopf m
economizer (i(ː)ˈkɔnəmaizə)	Wärmetauscher m, Ekonomiser m, Abgasvorwärmer m, Sparvorrichtung f
emergency power	Notleistung f
expel, to	vertreiben,austreiben, ausstossen, verdrängen
feed-water heater	Speisewasservorwärmer m
fireroom	Heizraum m
fire tube	Flammrohr n, Heizrohr n, Rauchrohr n
first cost	Anschaffungskosten pl, Herstellungskosten pl, Anlagekosten pl
flow passage	Durchflussöffnung f
four-stroke cycle	Viertakt m
fuel (fjuəl)	Brennstoff m, Treibstoff m, Kraftstoff m, Benzin n

fuel economy	Kraftstoffersparnis f
gas(oline)('gæsə,liːn, Am. auch ,gæsə'liːn) (US term for petrol)	Benzin n
gear	(mech) Getriebe n, Triebwerk n, Mechanismus m, Gang m, Zahnrad n
low gear	(auto) erster Gang, niedriger Gang
second gear	zweiter Gang
high gear	grosser Gang
reverse gear	Rückwärtsgang m
gland (glænd)	(mech) Stopfbüchse f, Stopfbüchsendichtung f, Flansch m
governor	(mech) Regler m, Drehzahlregler m, Maschinenregulator m
grate	Feuerrost m, Gitterrost m
guides (gaidz)	(mech) Geradführung f
heat engine	Wärmekraftmaschine f
ignite, to (ig'nait)	(ent)zünden, bis zur Verbrennung erhitzen
ignition (ig'niʃən)	Zündung f
ignition distributor	(auto) Zündverteiler m, Verteiler m
impulse turbine ('impʌls ...)	Gleichdruckturbine f, Aktionsturbine f
impulse reaction turbine	Gleichdrucküberdruckturbine f
impulse wheel	Gleichdruckrad n
indicating gauge (... geidʒ)	Ablesegerät n, Anzeigegerät n
inject, to	einspritzen, injizieren
intake	(mech) Ansaugen n, Einlass m
intake air	Ansaugluft f
internal-combustion engine	Verbrennungsmotor m
jet thrust (dʒet θrʌst)	Strahlschub m
low-pressure turbine	Niederdruckturbine f
lubricating system	Schmiersystem n
mechanical engineering	Maschinenbau m, Maschinenbauwesen n
nozzle	Düse f
overhaul ('ouvəhɔːl)	(mach) Ueberholung f
piping	Rohrleitung f, Rohrleitungssystem n, Rohrfernleitung f
piston stroke	Kolbenhub m, Kolbenbewegung f
power generation	Krafterzeugung f
power train	Kraftübertragung f

prime mover	Antriebsmaschine f, Kraftmaschine f, Zugmaschine f, Primärmaschine f
product of combustion	Verbrennungsprodukt n
propel, to	(an)treiben, bewegen
propeller thrust	Schraubenschub m
reaction turbine	Rückstossturbine f, Reaktionsturbine f
rotor	(mech) Rotor m, Läufer m, Flügelrad n, Laufrad n
runner	(mech) Laufrad n, Läufer m, Rolle f
scavenging ('skævindʒiŋ)	(mech) Spülung f
serviceability	Brauchbarkeit f, Verwendbarkeit f
shaft	(mech) Welle f, Achse f, Spindel f
slide valve	Schieberventil n, Schieber m, Absperrschieber m
soleplate	(mach) Lagerplatte f, Sohlenplatte f
spark-ignition engine	Zündermotor m
spark(ing) plug	Zündkerze f
squeeze, to (skwiːz)	quetschen, zusammendrücken, pressen
steam engine	Dampfmaschine f, Lokomotive f
steam-power plant	Dampfkraftwerk n, Dampfkraftanlage f
stoker	(mech) automatische Brennstoffzuführung
straight-tube boiler	Sektionalkessel m
stuffing-box ('stʌfiŋ...)	(mech) Stopfbüchse f, Stopfbuchse f
superheater	Ueberhitzer m, Dampfüberhitzer m
superposed turbine	Vorschaltturbine f
surface condenser	Oberflächenkondensator m
sustained	ununterbrochen, (an)dauernd, Dauer ...
turbine ('təːbin; -bain)	Turbine f
turbo-jet engine ('təːbou'dʒet...)	Turbinen-Luftstrahltriebwerk n
turbo-supercharger	Turbolader m
two-stroke engine	Zweitaktmaschine f, Zweitaktmotor m
valve rod	Schubstange f, Ventilbetätigung f
vane (vein)	(mech) Blatt n, Flügel m, Schaufel f
vessel	Gefäss n, Behälter m
volatility	(chem) Flüchtigkeit f

GRAMMAR and NOTES

1. The diesel engine uses fuels costing less than half as much as gasoline.
   In great contrast to a steam-power plant, a small diesel engine has nearly as good an economy as a large one.

Der Vergleich (Comparison)

a) Gleichheit wird durch as ... as = "(eben)so ... wie" festgestellt:

She is as tall as he is. Sie ist ebenso gross wie er.

Anmerkung 1: Gelegentlich findet sich der unbestimmte Artikel zusammen mit unbetontem one (als Stützwort) wie z.B. nach as + Adjektiv:

We had a very good summer last year. I hope we shall have as good a one this year.

Letztes Jahr hatten wir einen guten Sommer. Hoffentlich haben wir dieses Jahr einen ebenso guten.

Bei Ungleichheit benutzt die Umgangssprache (als stärkere Form) ebenfalls as ... as, während die Schriftsprache not so ... as bevorzugt:

It isn't as bad as it seems. Es ist nicht so schlimm, wie es aussieht.

It is not so bad as it seems.

b) Ein höherer Grad wird durch den Komparativ + than (="als") ausgedrückt:

You know her better than I do. Du kennst sie besser als ich.

Ein geringerer Grad kann durch less + Positiv (+ than) bezeichnet werden:

Try to be less impatient. Versuchen Sie, weniger ungeduldig zu sein.

Stilistisch besser ist aber meist der positive Ausdruck:

Try to be more patient. Versuchen Sie, geduldiger zu sein.

c) Die *Verneinung* beim *Komparativ* erfolgt in der Regel durch *no* (= not any):
There were *no* fewer than fifty people there.
Es waren *nicht* weniger als fünfzig Leute da.
I have *no* more to say. Ich habe *nichts* weiter zu sagen.
whether or *no* = in beiden Fällen; so oder so.

Anmerkung 2: Auch nach *than* und *as* wird in der Umgangssprache (hinter Adjektiven oder intransitiven Verben) gewöhnlich der *Objektskasus* gebraucht. Dies ist stets der Fall, wenn das Personalpronomen mit *all* oder *both* gekoppelt ist:

You're as tall as *me* (or I), in fact you're taller than *us both*.
Du bist so gross wie ich! Tatsächlich, du bist grösser als *wir beide*!

Anmerkung 3: Nach den Vergleichspartikeln *as* und *than* kann auch die *for-Konstruktion* auftreten:

Nothing is so easy as *for a young lady to raise* her expectations too high.
Nichts geschieht so leicht, *als dass* eine junge Dame ihre Erwartungen zu hoch spannt.

2. Evacuation of the products of combustion and admission of a new charge take place during the *latter* part of the expansion, and the early part of the compression stroke.
Während *latter*/*last* die *Reihenfolge* bezeichnen (als Gegensatz zu *former* bzw. *first* oder *next*), beziehen sich *later*/*latest* auf das *zeitliche* Verhältnis (als Gegensatz zu earlier/earliest):
the *latter* half of the century = die letzte(re) Hälfte des Jahrhunderts
the *latter* = der letzte(re), dieser
That's the *last* thing I should do = Das ist das letzte, was ich tun würde.
The *latest* news = die neueste(n) Nachricht(en)

Soll auf zwei vorher genannte Personen oder Sachen verwiesen werden, so steht the former im Sinne von "jener, der erstere" und the latter im Sinne von "dieser, der letztere":

... Of these two men the former is a doctor and the latter an artist. Der erste(re) dieser beiden Männer ist ein Arzt, der letztere ein Künstler.

3. generation = 1) Erzeugung, 2) Entwicklung, 3) Herstellung:

generation of current - Stromerzeugung f
generation of gas - Gasentwicklung f
generation of heat - Wärmeentwicklung f, Wärmeerzeugung f
generation of threads - Herstellung von Gewinden (nach dem Abwälzverfahren)
generation of water gas - Wassergaserzeugung f, Wassergasherstellung f

4. Motor (als Elektromotor) = motor (a machine for turning some form of energy into motion; an electrical motor converts electrical energy into mechanical energy).

(als Verbrennungsmotor) = engine (in general, a machine in which heat is converted into work).

5. Dampf = a) steam (water vapour at a temperature at or above the boiling point of water; by analogy the vapour of any liquid)

b) vapour (a gas of which the temperature is below the critical temperature, hence it can be liquefied by compression only, without temperature reduction being essential).

EXERCISES

1. Change the sentences in the negative into the positive and vice versa:

1) The list of reference books was not so detailed as we needed. 2) He speaks English as fluently as you do. 3) His advice is not so important as we believed. 4) It is as difficult as you say. 5) This idea is not so interesting as your suggestion. 6) This evidence is as exact as necessary. 7) He is as old as you.

8) The textile production in that country is as large as in Great Britain. 9) My room is as light as your office.

2. Write one sentence for each set of items, comparing (a) with (b) in respect of characteristic (c).

Example: (a) Steel
(b) Concrete
(c) Tensile strength
Steel has a greater tensile strength than concrete.

I a) Piston-engined aircraft
b) Jet-engined aircraft
c) Landing speeds

II a) Inter-continental airliners
b) Short-haul airliners
c) Operating ranges

III a) Black surfaces
b) White surfaces
c) Light absorption

3. Translate into English:

1) Die Unterspannung ist am grössten, wenn das Netz am stärksten belastet ist. 2) Es scheint, als ob diese Theorie von den meisten Forschern, die auf diesem Gebiet arbeiten, angenommen ist. 3) Wer jemals über eine Entfernung von mehreren hundert Kilometern telefoniert hat, weiss, dass die Antwort scheinbar ebenso schnell da ist, als wenn der andere Sprechende uns gegenüber sässe. 4) Die Kosten jener Konstruktion sind allzu gross, als dass sie wirtschaftlich tragbar wären.

ELECTRICAL ENGINEERING

(Basic Electricity)

Electrical Units. Terms and Definitions

The VOLT.- The Volt is the unit of electromotive force, or electric potential. It is that potential difference which will cause a current of 1 ampere to flow through a resistance of 1 ohm.

The AMPERE.- The ampere is the unit of electric current. It is that amount of current which will flow through a resistance of 1 ohm when a potential of 1 volt is applied across the resistance.

The OHM.- The ohm is the unit of resistance. It is that amount of resistance which will permit 1 ampere to flow at a potential difference of 1 volt.

The MHO.- The mho is the unit of conductance. It is the reciprocal of resistance; that is, the relation between conductance G and resistance R is given by $G = \frac{1}{R}$

If the resistance is thought of as representing the difficulty with which an electric current is forced through a circuit, the conductivity may be thought of as the ease with which an electric current may be forced through the same circuit. Note that the word "mho" is simply "ohm" spelled backward.

The WATT.- The watt is the unit of electrical power. In direct-current circuits the power in watts is the product of the voltage times the current,or

$$P = EI$$

The HENRY.- The henry is the unit of inductance. A circuit is said to have a self-inductance of 1 henry when a counter-electromotive force of 1 volt is generated by a rate of change of current of 1 ampere per second.

The FARAD.- The farad is the unit of capacitance. A condenser is said to have a capacitance of 1 farad when a change of 1 volt per second across it produces a current of 1 ampere.

Cycle and Period.- The complete series of changes consisting of the growth and decay of the voltage or current in one direction, together with its growth and decay in the reverse direction, is called one cycle. A voltage or current that is reproduced at equal intervals is said to be periodic, and the minimum time interval elapsing before the same instantaneous value recurs is called the periodic time or the period.

Frequency.- The number of complete cycles per second through which a voltage or current passes is called the frequency. It is always expressed in cycles per second, the reciprocal of this number being the periodic time. Frequencies are now standardized for power purposes in the principal countries of the world, the standard for Great Britain being 50 cycles per second, while the U.S.A. has adopted 60 cycles per second.

Wave Form.- The shape of the graph of the voltage or current, when plotted against time as a base, is called the wave form or wave shape. The ideal aimed at is that of the sine wave, i.e. the graph has the same shape as the graph of a sine function in mathematics. The sine goes through 360° in a complete cycle, and so the time scale on the wave form of a voltage or current is usually represented in degrees, 360° being considered the equivalent of the time corresponding to 1 cycle, or the periodic time. Since these degrees may not always coincide with the geometrical degrees through which the rotating member of a machine has been rotated, they are called electrical degrees, in order to distinguish them from geometrical degrees. One cycle is thus regarded as the equivalent of 360°, and 180° is considered as a half-cycle, i.e. the duration of the voltage or current in one direction only.

Difference between A.C. and D.C. - A direct current (D.C.,d.c.,dc) flows continuously through a conduction circuit in one direction only, although it may not be steady so far as magnitude is concerned. It is unidirectional in character. An alternating current (A.C.,a.c.,ac), on the other hand, continually reverses in direction, as its name implies. Starting from zero, it grows in one direction, reaches a maximum, dies down to zero again, after which it rises in the opposite direction, reaches a maximum, again dying down to zero. It is thus continually changing in magnitude as well as direction, and this continual change causes certain effects of far-reaching importance.

Phase and Phase Difference.- During the interval of time necessary for a current to pass through one complete cycle, it passes through many phases. In fact, it has a different phase for each different interval of time. Consider the analogous case of the phases of the moon.

Starting from the time of new moon, the moon passes through its various phases, measured by its age from the time of the new moon, up to full moon, and then onwards through the various stages of the waning moon. Similarly an alternating current goes through various phases, starting from zero, rising up to maximum, and dying down again to zero. In the A.C. case, however, this comprises only half a cycle, for the whole series of values are then repeated in the opposite (negative) direction. Other electrical quantities, such as voltage, power, etc., in addition to current go through various phases from 0° to 360°; indeed all quantities which vary in a periodic manner do so.

When two voltages or two currents are considered together, however, or when a voltage and current are considered simultaneously, the frequency being the same, they may not pass through the same phase at the same instant of time. For example, two currents may be such that, although their frequency may be the same, their phase at a particular instant of time may be different. One may pass through its maximum value at the instant when the other has a zero value, or some other value not its maximum value; the two currents, etc. are then said to have a phase difference, this being quoted in degrees. If one current has its maximum value at the same time that the other is zero, the two currents are said to be in quadrature; they have a phase difference of 90°. Phase difference, because it is constant in a circuit where steady conditions obtain, is much more important in a.c. work than the actual phase which varies from instant to instant. An alternating current varies in strength from instant to instant, and reaches a maximum value twice in every cycle, once in each direction. This maximum value is called the crest value.

Inductance.- When a current flows through a conductor it sets up a magnetic field in the neighbourhood of the conductor. This is negligible in its effects in a number of cases, but there are also many cases where this magnetic field exerts a profound effect upon the circuit. The magnetic field created by the current is represented by lines of magnetic flux, these lines consisting of closed loops which are interlinked with the electric circuit, itself necessarily a closed circuit. If the current is steady, the magnetic flux is constant and produces no effect upon the circuit, but if the current changes then the strength of the magnetic field also changes. If the current increases, the total number of lines of magnetic flux is increased, so that the total number of flux linkages is also increased. It is, however, a fundamental law that whenever the number of flux linkages changes, an electromotive force (e.m.f.,emf,EMF) is induced in the circuit linked with the flux. This e.m.f. is proportional to the rate of change of linkages, and one volt is induced when the linkages change at the rate of 10^3 linkages per second.

Mutual Inductance.- When inductance is due to flux linking with the same circuit that carries the current, it is called self-inductance, in order to distinguish it from inductance due to flux linking with the circuit due to current in a neighbouring circuit, which is called mutual inductance. In the latter case, two circuits are said to possess mutual inductance if a change of current in one circuit causes an e.m.f. to be induced in the other circuit.

Hysteresis.- When a ferromagnetic material is subjected to varying magnetic fields, such as changes in direction and intensity, the magnetic induction will lag behind the changes in the magnetizing force. This lag in magnetization is called hysteresis and is the result of an internal friction within the substance. The heat produced by this friction represents a power loss. When a ferromagnetic material is used with a-c equipment, such as transformers, or with rotating equipment, such as motors or generators, the material is subjected to a cyclical change in both direction and intensity. The energy loss occuring during each cycle is represented by a hysteresis loop.

Eddy Currents.- Eddy currents are circulating currents that are induced in a material by a varying magnetic field. These currents are undesirable, as they produce heat and thus represent a loss in energy. The iron cores of transformers and the poles, armature, rotors, and stators for rotating electrical equipment are constructed of laminated sheets that are electrically insulated from each other, thus restricting the eddy currents to individual sheets. The thinner the laminations, the greater will be the reduction of the eddy currents. Eddy currents are reduced in powdered cores by use of a binder that insulates each metallic particle electrically from one another.

Three-phase System.- In an ordinary a.c. circuit the current goes through all its phases in succession, but at any particular instant the current has only one phase. In the three-phase system there are three circuits, and the currents in these have three different phases at the same instant of time. The phase difference between any two of these three phases is 120°. In practice it is usual to arrange the armature conductors on the stationary element of the machine, now called the stator, the d.c. excited field forming the rotating element, or rotor. Each winding also is made to consist of many turns. It does not matter, however, whether the conductors cut the magnetic flux, or the magnetic flux cuts the conductors; the action is the same.

Insulation and Insulators.- It is common knowledge that electrical insulation has several functions. It prevents bare wires from touching each other and thus allowing excessive amounts of current to flow. It prevents a person from receiving an electric shock. It also prevents excessive leakage currents from flowing and thereby wasting energy and probably producing unwanted temperature rise. High-voltage transmission and distribution lines are constructed with bare wire and supported by insulators of various types. Distribution lines in newer residential areas are sometimes installed underground.

Semiconductors.-In electrical engineering, materials are often classed as *insulators* (e.g., glass, rubber, mica, air) or *conductors* (e.g., copper, aluminium, platinum). Certain materials, however, fall into neither of these groups; their resistivity is too high for them to be called conductors, too low for classification as insulators. Among these semiconductors are *silicon*, *germanium*, *selenium*, and *cuprous oxide*, the last two being commonly used in the metallic rectifiers. Semiconductors may be made to have very useful properties in the conduction of electricity. For these applications, germanium and silicon are important materials. A germanium crystal has an atomic structure containing four valence electrons; that is, each atom of germanium has four electrons in its outer orbit which are shared with neighbouring atoms. If a slight impurity is added, the balance of electrons may be upset. The addition of a five-valence impurity, such as antimony, results in a crystal with an excess of electrons. Such a crystal is called n-type germanium (n for negative). The addition of a three-valence impurity, such as *indium* or *gallium*, results in a shortage of electrons. This deficiency gives rise to the term positive holes to describe the electron absences. The holes may become mobile as an electron absence is transferred from one germanium atom to another in the crystal structure. They may usually be thought of as the equivalent of positively charged particles capable of taking part in the conduction of electricity through the crystal. A p-type crystal (p for positive) is the result. For either n-type or p-type crystals, the amount of impurity is very small, about 1 part in 100 million. Extreme care must be exercised in the growth and manufacture of the crystals.

The Use of Electricity as a Source of Energy.- In the early years of the twentieth century, electricity was just beginning to be used as a source of energy in the fields of illumination, power, and communication. Electrical energy is used in varying quantities and is produced by several methods in order to meet a wide range of power requirements. The large power plants near our population centres and industrial areas are familiar sights. Such power plants supply millions of kilowatt hours of electrical energy for operating lights, home appliances, industrial equipment, communication equipment, and railway transportation equipment. The large amounts of power required by these services may be produced by converting heat energy (obtained from coal, oil, gas, or atomic reactors) to electrical energy and converting water power to electrical energy. Another widely used source of electrical energy is the chemical cell which converts stored chemical energy to electrical energy. Two familiar applications of this type of power source are (1) the primary cell, as used in transistor radio receivers and electronic test equipment, and (2) the secondary cell, as used in storage batteries for automobiles.

A relatively new source of electrical energy is the solar cell which converts light energy, obtained from the sun, to electrical energy. This type of power sources is now being used in the control and monitoring equipment for satellite and space vehicles and is providing our scientists with much new information about outer space.

Another new source of electrical energy is the fuel cell. This type of cell, unlike the ordinary chemical cell, does not store energy but, rather, converts the energy from conventional fuel oxidation directly to electrical energy. The fuels used are of the inexpensive fossil types, such as coal and hydrocarbons or substances easily derived from them, as hydrogen, alcohol, carbon monoxide, etc.

The Solar Cell.- The solar cell is based on the principle that, when a silicon crystal is exposed to light, light rays are absorbed by the crystal by liberating fre-to-move negative charges, called electrons, and free-to-move positive charges, called holes.

The direction of movement of the electrons and holes can be controlled to produce an electric current. The strength of this current is dependent upon the size of the crystal and the intensity of the source of light. The efficiency of a solar cell in converting light energy to electrical energy is dependent upon the following factors: (1) the intensity of the light source, (2) the spectral content of the light waves, (3) the angle at which the light waves strike the surface of the cell (angle of incidence), (4) the operating temperature of the cell, and (5) the characteristics of the external circuit. The solar cell has an output of approximately 0.4 volt, and cells may be connected in series to increase the voltage output and in parallel to increase the current output. The simplicity of a solar cell permits its construction to be relatively rugged. These cells have a high output level, and indefinite life, and a nonageing characteristic.

A highly publicized application of the solar cell is to provide the power requirements of satellites and space vehicles. Solar cells are used in these applications to charge storage batteries and to supply power during that portion of the orbit when the cells are in direct sunlight. The storage battery provides a continuity of power for instrumentation, transmitters, and telemetry systems during the periods of darkness when the cells are inoperative. Because of its advantages, the silicon solar cell is finding increased and varied industrial applications. This type of cell is used extensively in data-processing equipment to read punched tape, punched cards, or film. It is also used as power supplies for remote and unattended radio stations,lighthouses, beacons, and telephone repeaters in sunny areas. Other potential uses of solar cells are (1) light-operated transistor radio, (2) light-controlled toys, (3) automatic street lighting, (4) analogue-to-digital encoders, (5) servo-mechanism, (6) gyrocompasses, (7) light-operated burglar alarms, (8) modulated light-beam communication.

Electrical Measurements.- Electrical measuring instruments can be divided into three classes: indicating instruments, recording instruments and integrating instruments.

Indicating instruments, such as ammeters, voltmeters and wattmeters, constitute the largest of the three classes. These are fitted with a pointer which moves over a fixed scale and their characteristic is that they give an immediate indication of the value of the current, voltage or other quantity being measured.

Recording instruments, or graphers, as they are sometimes called, instead of being fitted with a pointer and scale, carry a pencil or pen, which presses on to a travelling ribbon of paper, and thus makes a continuous chart or record of the values measured. It will be noted that these two types do not differ in principle, since they are both used to measure the same kinds of things; but in the one case the indication is momentary and must be read by an observer on the spot, whilst in the other case the values are recorded on a chart for future observation and reference.

The third group, consisting of integrating instruments or electricity supply meters, differs fundamentally from the other two groups, since instead of indicating or recording,these instruments add up the total amount consumed over any given period. Thus, instead of reading, say, the current or the power flowing at any instant, they measure the product of current and time (in ampere-hours) or of power and time (in watt-hours), and so add up the electrical quantity or energy consumed.

All indicating instruments have three essential features: an operating force or mechanism, a controlling force or mechanism, and a damping force or mechanism.

When an electric current flows, it gives rise to various effects — heating, electrostatic, electromagnetic and chemical, and any one of these effects can be utilized to furnish the operating force of a measuring instrument.

QUESTIONS

1) What are electrical conductors used for ?
2) What does the resistance of a wire depend on ?
3) Of what do you think when you hear the names of Faraday, James Watt, Ohm ?
4) Can you give the names of some famous discoverers and inventors?
5) Can you explain the difference between an invention and a discovery?
6) What do we understand by a "phase difference " ?
7) What do we mean by "hysteresis" ?
8) What are eddy currents ?
9) What is understood by "semiconductors" ?
10) In what way can we produce electrical energy ?
11) For what purposes do we use electrical energy ?
12) Can you name some home appliances using electrical energy ?
13) Can you define a) cell, b)primary cell, c)secondary cell, d) battery ?
14) Can you give a short account of the basic principle of a solar cell?
15) What are the principal advantages of a solar cell ?
16) Where and how are solar cells applied in industry ?
17) What is the basic principle of a fuel cell ?
18) What is an electrical measuring instrument ?
19) What kinds of electrical measuring instruments do you know ?

IMPORTANT TERMS

alternating current	- Wechselstrom m
ammeter	- Amperemeter n, Strommesser m
analog-to-digital encoder (U.S.)	- Analog-Digital-Wandler m
angle of incidence	- Einfallswinkel m
applied power	- zugeführte Leistung
applied voltage	- angelegte Spannung, zugeführte Spannung

armature ('aːmətjuə)	(el) Anker m, Läufer m, Rotor m
bare wire	blanker Draht
beacon ('biːkən)	Backe f, Navigationsbacke f ; (electron) Funkfeuer n, Leitstrahlsender m
binder ('baində)	Bindemittel n
burglar alarm ('bəːglə ···)	Alarmglocke f, Einbruchsicherung f
capacitance	Kapazität f
carbon monoxide (···mə'nɔksaid)	Kohlenmonoxyd n,Kohlenoxyd n, Koksgas n
cell	(el chem) Element n; (gen) Zelle f; (comput) Speicherzelle f
circuit ('səːkit)	Stromkreis m; Schaltung f
in circuit	angeschlossen
out of circuit	stromlos
closed loop	(el) geschlossener Kreislauf
crest value	(el) Scheitelwert m, Spitzenwert m
cuprous oxide	Kupfer - I - Oxid n, Cuprooxyd n
current ('kʌrənt)	Strom m
cycle ('saikl)	Zyklus m, Umlauf m, Periode f
damping	Dämpfung f
decay (di'kei)	(electron) Abklingen n, (el) Dämpfung f; (nucl) Zerfall m
decay of current	Abfall m des Stromes
deficiency	Mangel m, Fehlen n, Unzulänglichkeit f
die, to (down)	abflauen, abklingen
direct current	Gleichstrom m
distribution line	Verteilungsleitung f
eddy current	Wirbelstrom m
electrical engineering	Elektrotechnik f
electromotive force (emf)	elektromotorische Kraft (EMK)
energy loss	Energieverlust m
flux	Fluss m, Kraftfluss m, Induktionsfluss m; Löt(fluss) mittel n
flux linkage	(el) Flussverkettung f
fuel cell	Brennstoffzelle f Brennstoffelement n

germanium (dʒəːˈmeiniəm)	Germanium n
gyrocompass	Kreiselkompass m
hysteresis (ˌhistəˈriːsis)	Hysterese f
hysteresis loop	Hystereseschleife f
illumination	Beleuchtung f; Lichttechnik f
impurity	Verunreinigung f (gezielte), Fremdatom n
indicating instrument	Anzeigeinstrument n, anzeigendes Messgerät
input	Eingang m, Eingangsleistung f, Eingangssignal n; (comput) Eingabe f
insulate, to	isolieren
insulating medium	Isolationsstoff m, Isoliermaterial n
insulation	Isolierung f, Isolation f
insulator	Isolator m, Nichtleiter m
instantaneous value	Augenblickswert m, Momentanwert m, Istwert m
instrumentation	Instrumentenausstattung f
integrating instrument	integrierendes Messinstrument, Zähler m
interlink, to	verketten
iron core	(el) Eisenkern m, Weicheisenkern m
lag, to (behind)	nacheilen (Phasenverschiebung)
leakage current	Leckstrom m, Kriechstrom m
light - operated	photoelektrisch
lighting	Beleuchtung f
magnitude of current	Stromstärke f
mica (ˈmaikə)	Glimmer m
modulated light-beam communication	Uebermittlung f von Nachrichten durch moduliertes Licht
mutual inductance	Gegeninduktivität f
nonageing	alterungsbeständig
output	Ausgang m, Ausgangsleistung f; (comput) Ausgabe f

phase difference	Phasendifferenz f, Phasenunterschied m, (phase displacement)
plot, to (against)	auftragen, aufzeichnen, diagrammatisch darstellen
pointer	Zeiger m, Nadel f
positive hole	positives Loch, Elektronenfehlstelle f, Defektelektron n, Gitterlücke f
power loss	Energieverlust m, Leistungsverlust m
power supply	Stromversorgung f, Energieversorgung f, Energiezuführung f
power supply system	Starkstromnetz n
punched card (pʌntʃt ...)	Lochkarte f
punched tape	Lochstreifen m
rate of change	Aenderungsgeschwindigkeit f
recording instrument	Schreiber m, registrierendes Messgerät
rectifier circuit	Gleichrichterschaltung f
recur, to (ri'kəː)	wiederkehren, sich wiederholen
rotor	(el) Anker m, Läufer m, Rotor m
satellite ('sætəlait)	Satellit m
scale	Skala f, Gradeinteilung f; Waagschale f, Waage; Masstab m
selenium (si'liːnjəm)	Selen n
self-inductance	Induktivität f, Selbstinduktionskoeffizient m
semiconductor	Halbleiter m
servomechanism	Servomechanismus m, Stellmotor m
shortage	Knappheit f, Mangel m
space ship	Raumschiff n
stator	Ständer m, Stator m
storage battery	Sammler m, Akkumulator m (Akku)
telemetry	Fernmesstechnik f Telemetrie f
telephone repeater	Telephonverstärker m, Fernsprechverstärker m
time scale	Zeitmass n
time-scale instrument	Zeitskaleninstrument n

transformer	- Transformator m, Umformer m, Umspanner m
transmission line	- Uebertragungsleitung f
unidirectional	- in einer Richtung verlaufend
upset, to	- umwerfen, umkippen
valence electron	- Valenzelektron n
vehicle (ˈviːikl)	- Fahrzeug n, Gefährt n
voltage (ˈvoultidʒ)	- (el) Spannung f
voltage drop	- Spannungsabfall m
voltage output	- Ausgangsspannung f
voltage rating	- Nennspannung f
voltage rise	- Spannungsanstieg m
winding (ˈwaindiŋ)	- (el) Wicklung f
wiring (ˈwaiəriŋ)	- Verdrahtung f, Leitungsführung f

GRAMMAR and NOTES

1. An alternating current (A.C.), on the other hand, continually reverses in direction, as its name implies.

   One cycle is thus regarded as the equivalent of 360°, and 180° is considered as a half-cycle, i.e. the duration of the voltage or current in one direction only.

Vielfältig sind die Funktionen von "as":

a) kausal = "da" (because; since):

As it is wet, we shall stay at home.
Da es nass ist, bleiben wir zu Hause.

b) temporal = "als, während" (when, while):

As he walked on, he got more and more tired.
Beim Weitergehen (Während er weiterging,) wurde er immer müder.

c) = "(so) wie" (in the way that):

He came early, as he had been asked (to do).
Er kam zeitig, wie man ihn gebeten hatte.

d) = "wie, als" (in the manner of):

He was treated as a friend, not as a stranger.
Er wurde als (oder: wie ein) Freund behandelt, nicht als Fremder.

Kausales as wird (wie "da") gewöhnlich im vorangestellten Nebensatz verwendet, während because (wie "weil") meist im nachgestellten Nebensatz steht. - Besonders umgangssprachlich wird as (kausal und temporal) gern gebraucht, jedoch durch because oder while ersetzt, wenn sonst Missverständnisse entstehen könnten.

Anmerkung: Bei vergleichendem as ... as wird das zweite as in der Umgangssprache gewöhnlich als Präposition aufgefasst:

He's as tall as me (Präposition + Objektskasus)mit He is as tall as I (am). Zu beachten ist auch die konditionale Bedeutung von unterordnendem as long as / so long as (= if only; provided that):

You may borrow my books as long as you keep them clean.

Du kannst meine Bücher entleihen, wenn du sie sauber hältst.

2. If one current has its maximum value at the same time that the other is zero, the two currents are said to be in quadrature; they have a phase difference of 90°.

That nach Zeitangaben:

a) Now (that) = "jetzt, wo" (as; considering that):

Now (that) you are well again, you can travel.

Jetzt, wo es Ihnen wieder gutgeht, können Sie reisen!

b) Nach Substantiven steht that hier als Wortart zwischen Konjunktion und Relativpronomen:

By the time (that) you have finished, it will be too late.

Bis (dass) du fertig bist, wird es zu spät sein!

I met her the year (that) she came here.

Ich traf sie in dem Jahr, in dem sie hierherkam.

Eine ähnliche Zwischenstellung als Wortart hat that z.B. auch in:

It's to you (that) I'm talking. It's you (that) I'm talking to.

Ich spreche mit Ihnen! Mit Ihnen spreche ich!

dry cell

3. Der Text enthält eine besonders grosse Zahl von Fremdwörtern. Diese Fremdwörter (meist) griechischen Ursprungs betonen fast regelmässig die drittletzte Silbe:

electricity
electrical
electrolyte

chemistry
chemical
hydrogen

mechanism
theory
theoretical

electrolysis
metallurgy
hydroxyl etc.

Das gleiche Betonungsschema haben folgende Fremdwörter, die in anderen Texten vorkommen:

thermometer
telephone
technology
arithmetic
barometer

diameter
phenomenon
galvanometer
telephony
telegraphy
oxygen

technological
arithmetical
diametrical
energy
geometrical
nitrogen

tachometer
telegraph
geometry
ionosphere
telemetry

Dagegen : electric, electron, electronic(s), electrolytic(s)

Fachsprachliche Pluralformen von Substantiven lateinischer oder griechischer Herkunft:

	Singular		Plural
- a:	abscissa	-ae:	abscissae
	antenna		antennae
	formula ('fɔːmjulə)		formulae ('fɔːmjuliː), auch: formulas (-əz)
	nebula		nebulae
- ex:	apex	-ices:	apices auch: apexes
	index		indices ('indisiːz), auch: indexes (-eksiz)
	vertex		vertices
-is:	axis	- es:	axes
	basis		bases
	analysis (ə'næləsis)		analyses (-iːz)
	hypothesis (hai'pɔθisis)		hypotheses (-iːz)
	paranthesis		parantheses
	thesis ('θiːsis)		theses (-iːz)
	crisis ('kraisis)		crises (-iːz)

- ix:	appendix	-ices:	appendices, auch: appendixes
	helix		helices
- on:	criterion (kraiˈtiəriən)	- a:	criteria (kraiˈtiəriə)
	phenomenon (fiˈnɔminən)		phenomena (fiˈnɔminə)
- um:	addendum	- a:	addenda
	erratum		errata
	equilibrium		equilibria
	fulcrum (ˈfʌlkrəm)		fulcra (ˈfʌlkrə)
	medium		media
	momentum		momenta
	quantum		quanta
- us:	focus (ˈfoukəs)	- i:	foci (-sai), auch: focuses (ˈfoukəsiz)
	locus (ˈloukəs)		loci (ˈlousai)
	radius (ˈreidjəs)		radii (-diai), auch: radiuses (ˈreidjəsiːz)
	stimulus (ˈstimjuləs)		stimuli (-ai)
	apparatus (ˌæpəˈreitəs)		aber: apparatus(es) (-iz)

Aehnlich auch Wörter aus dem Französischen:

chassis (ˈʃæsi)	chassis (-iːz), auch: chassises (ˈʃæsisiːz)

Anmerkung: "data" - Plural von "datum" - wird jetzt häufig als Singular behandelt: This data was transmitted by a satellite.

4. Electric - electrical.

Die Verwendung der Termini ist nicht wahlfrei, eine Regel jedoch schwer zu formulieren. Das seltenere "electrical" wird benutzt:

A. Bei Termini mit allgemeiner Bedeutung: electrical machine,
electrical equipment,
electrical system u.a.

B. Oftmals, wenn das Bestimmungswort vokalisch anlautet:

electrical engineering
electrical instrument
electrical industry
electrical energy etc.

C. Zur Kennzeichnung der elektrischen Eigenschaft:

electrical resistance
electrical susceptibility
electrical sensitivity
etc.

5. Synonyme Wendungen zum Einprägen:

The field exerts a force on the positive charge.
The field exerts an influence on the positive charge.
The field exercises an influence on the positive charge.
The field influences the positive charge.
The field affects the positive charge.

6. to be due to hat—nach dem französischen Ursprung des Wortes—die Grundbedeutung "gebühren", zu verdanken sein". Es heisst auch "zurückzuführen sein auf, beruhen auf"; oft ist eine "freiere" Uebersetzung notwendig.

due to: infolge, bei; due (als Attribut): entsprechend, angemessen...

7. Beachten Sie:

to lag - nacheilen
to lead
to be ahead of } voreilen
to be in phase (with) - in Phase sein (mit), phasengleich sein (mit)
to be in antiphase (with) - gegenphasig (verlaufen)
with rotating equipment - bei (in) rotierenden Maschinen
to plot H against B - H (die Feldstärke) über B (der Flussdichte) auftragen

8. Word Study:

Die sehr häufige Ableitungssilbe -ize/-ise*(dazu: -ization, -izable, -izability) entspricht im Deutschen meist "-ieren, -ierung, -ierbarkeit.* (-ise ist britische Schreibweise):

to ionize: to produce ions; ionization, ionizability
to magnetize: to render a substance, such as iron, steel, or similar substances magnetic; magnetization; magnetizability.

9. in terms of modern magnets - ....verglichen mit... Für die Uebersetzung der Wendung "in terms of" läst sich keine Regel aufstellen. Mögliche Uebersetzungen sind u.a. :"in der Sprache von", "in Form von", "als".

Term = a) Termin m (term of payment)
b) Frist f (a long-term credit)
c) Semester n (during winter term, during spring term)
d) Begriff m, Fachausdruck m, Bezeichnung f (Most scientists use the term in the sense given here.)
e) Glied n, Ausdruck m (The right-hand term of the equation may be simplified.)

10. resistivity - Widerstandsvermögen n, Widerstand m; meist "spezifischer Widerstand". In der Physik wird der Widerstand meist zwischen den entgegengesetzten Flächen (opposite faces) eines Würfels mit einer Kantenlänge von 1 cm (unit cube) zur Definition herangezogen und als "volume resistivity" bezeichnet.

Widerstand als Bauelement heisst "resistor", manchmal auch "resistance".

"Surface resistivity" heisst entweder Oberflächenwiderstand (zur Bezeichnung der Erscheinung, der Tatsache) oder Flächenwiderstand (zur Angabe der Grösse, des Masses).

11. semi-halb / Halb - (auch "hemi-" vgl.hemisphere, hemicircle).

semi-automatic - halbautomatisch

semi-annual (semi-monthly)-halbjährig(halbmonatlich)

semi-circle - Halbkreis m

semi-finished products (semi-finishes) -Halbzeug n, Halbfabrikat n

semi-skilled - angelernt (semi-skilled workers)

12. n/p-type germanium = n-leitendes / p-leitendes Germanium.

13. Eine der häufigsten Nachsilben des Englischen ist "-able/-ible"; sie ist stets unbetont. Substantivableitung auf "-ability". Im Deutschen entsprechen häufig die Nachsilben "-bar/keit": obtainable (erreichbar), appreciable(bemerkenswert, nennenswert, [ab]schätzbar), probable (wahrscheinlich, vermutlich, mutmasslich)

14. cell-Element n. Der deutsche Begriff "Element" wird im Englischen verschiedenartig wiedergegeben:

Maschinenelemente	machine elements
Bedienungselement	operating agent, control, knob, button, switch
Uebertragungselement	transmission agent
Konstruktionselement	construction element
Galvanisches Element	galvanic cell, voltaic cell
Sekundärelement	secondary battery (cell)
Thermoelektrisches Element	thermoelectric cell
Thermoelement	thermo-couple
Nasselement	wet cell (battery)
Trockenelement	cry cell

15. unlike - im Gegensatz zu, im Unterschied zu

16. Beachten Sie bei der Uebersetzung der Verwendung der verschiedenen Begriffe für die Wortgruppe "Gerät","Vorrichtung","Apparat", "Einrichtung","Anlage", "Ausrüstung" , "Apparatur"

a) A device is (usually) a clever mechanism which is devised (invented/developed) to solve some particular mechanical problem. This is a very useful word for definitions and explanations and you can use it together with "switch, battery, transformer etc."

b) An instrument is usually a small manufactured object which enables us to perform some precise action or measurement. The ammeter is an instrument for measuring electric current.

c) A gadget is a small ingenious device.

d) An apparatus is (usually) a complicated mechanism or assembly of many different pieces used for scientific experiments or tests, or for practical purposes.-
The telephone apparatus consists in general of the microphone and the telephone receiver.

e) An installation is (1) the action of placing something in position for use and
(2) the complete apparatus or equipment, e.g. for electric lighting or for the production of electrical energy.

f) An equipment is (usually) all that is required for example by a factory for its production. The equipment of his laboratory took time and money. It is also the act of equipping or the state of being equipped.

g) An appliance is (usually) a thing that may be used (e.g.a tool) for doing something, as an appliance for opening tin cans or boxes (home appliances).

h) A plant (usually) all the machinery, tools, fixtures,etc. used in an industrial process, as a lighting plant (i.e. for providing gas, electricity, etc.)
Hunterston is Scotland's first nuclear power plant.
Today's industrial plants seldom consider generating dc for their power needs.

i) Facility (usually used in plural: facilities). Things or circumstances that help one to do something, as facilities for study (e.g. leisure, books, laboratories, etc.); facilities for travel (e.g. buses, trains, ships, good roads, etc.), facilities for efficient production, parking facilities, sanitary facilities, transportation facilities, etc.

PREFIXES DENOTING DECIMAL MULTIPLES OR SUB-MULTIPLES

Indicating multiples

X 10^{12} : tera .. .. T
X 10^{9} : giga .. .. G
X 10^{6} : mega .. .. M
X 10^{3} : kilo .. .. k

Indicating sub-multiples

X 10^{-1} : deci .. .. d
X 10^{-2} : centi c
X 10^{-3} : milli .. .. m
X 10^{-6} : micro .. .. μ
X 10^{-9} : nano .. .. n
X 10^{-12} : pico .. .. p
X 10^{-15} : femto .. .. f
X 10^{-18} : atto .. .. a

EXERCISES

1. Form sentences out of the following terms:

electric, electrical, electrically, electricity, electron, electrolyte, electrode, electrify, electrician, electronic, electrifiable.

2. Explain the words:

static electricity, negative electricity, frictional electricity, contact electricity, positive electricity, induced electricity.

3. Complete the antonyms and form different sentences:

deficiency of electrons - excess of electrons
negatively charged - .... charged
bound electrons - .... electrons
external resistance - .... resistance
unlike poles - .... poles
to switch on - to switch ......

4. Put in suitable prepositions:

1) He has worked ..... the field of physics for a couple of years.
2) Kirchhoff contributed much .... the physics of light and heat.
3) The famous scientist made many contributions .... electrical engineering.
4) Part of the current flows .... the junction.
5) We are just dealing .... currents ... a junction ... a network.
6) Temperature exerts an influence ... the resistance of a conductor.

5. Translate the following sentences into German and replace "as" by using other words or constructions (if possible):

Example: As the neutron is an uncharged particle, no repulsive forces are exerted on it.
Da das Neutron ein ungeladenes Teilchen ist, ...
Since the neutron is an uncharged particle, ...
The neutron being an uncharged particle .....:

1) As this cannot be proved, it must be accepted as an observed fact of nature.
2) In such a diagram, the terminal volts of the battery are plotted against days of service as abscissae.

3) Copper is preferred because of its unrivalled qualities as a conductor. 4) The uranium, as used in the reactor, is in the form of a thin rod. 5) This method, previously mentioned as affording good results, is widely used. 6) A compass needle indicates the direction of the flux to be as shown. 7) The surface charges will become static as soon as the resultant electric field within B is reduced to zero. 8)A rheostat is provided in the exciting circuit of the generator, so as to maintain the proper voltage. 9) This type of motor is referred to as an induction motor. 10) The earth is a conductor of electricity and as such may form part of an electrical circuit. 11) As the experiment is going on, let us watch what happens. 12) The stationary frame and the poles of the generator are made of some magnetic material, such as cast iron or steel. 13) The holes of a semicondcutor may become mobile as an electron absence is transferred from one germanium atom to another in the crystal structure. 14)The electron vacancies in the transistors came to be known as holes.

6. Translate into English:

1) Der Elektrizitätszähler ist ein Gerät zum Messen des Verbrauchs an elektrischer Energie. 2) Die Drehungen werden auf ein Zählwerk übertragen, das direkt Kilowattstunden anzeigt. 3) Für Wechselstrom wählt man vorwiegend Induktionszähler. 4) Ein Primärelement wird aus zwei Elektroden und dem Elektrolyten gebildet. 5) Die Elektroden, meist Metall und Kohle, wandeln in Verbindung mit dem Elektrolyten chemische Energie in elektrische Energie um. 6) Es entsteht ein Potentialunterschied. 7) Viele Stoffe dissoziieren, wenn sie in Wasser gelöst werden, das heisst einige ihrer Moleküle zerfallen in geladene Teilchen oder Ionen. 8) Die Anziehung zweier elektrisch geladener Körper hängt von der Natur des Mediums ab, in dem sie sich befinden. 9) Für Germanium wird vorwiegend Arsen und für Silizium hauptsächlich Antimon verwendet. 10) Elektrische Isolatoren sind Körper, die aus Isolierstoffen bestehen und in der Elektrotechnik besonders bei elektrischen Leitungen angewendet werden. 11) Gute Planung und verbesserte Arbeitsmethoden werden es ermöglichen, die Produktion wesentlich zu erhöhen.

Lesson Twenty-eight

ELECTRONICS

Radio Waves. - Electrical energy that has escaped into free space exists in the form of electromagnetic waves. These waves, which are commonly called radio waves, travel with the velocity of light and consist of magnetic and electrostatic fields at right angles to each other and also at right angles to the direction of travel.

One half of the electrical energy contained in the wave exists in the form of electrostatic energy, while the remaining half is in the form of magnetic energy.

The essential properties of a radio wave are the frequency, intensity, direction of travel, and plane of polarization. The radio waves produced by an alternating current will vary in intensity with the frequency of the current and will therefore be alternately positive and negative.

The distance occupied by one complete cycle of such an alternating wave is equal to the velocity of the wave divided by the number of cycles that are sent out each second and is called the wave length.

The Radio Frequency Spectrum

The part of the frequency spectrum of electro-magnetic radiation which may be used for radio communication extends from a few kilocycles/second to frequencies of about 100 Gigacycles/second (10^{11}c/s). For convenience this total bandwidth is divided into sections as listed in the following table:

Frequency band		Frequency range	Wavelength range
Extra low	e.l.f.	Below 3 kc/s	100 km and more
Very low	v.l.f.	3 ... 30 kc/s	100 ... 10 km
Low	l.f.	30...300 kc/s	10 ... 1 km
Medium	m.f.	0.3...3 Mc/s	1000...100 metres
High	h.f.	3 ... 30 Mc/s	100 ... 10 metres
Very high	v.h.f.	30...300 Mc/s	10 ... 1 metres
Ultra high	u.h.f.	300...3000 Mc/s	1 metre ... 10 cm
Super high	s.h.f.	3 ... 30 Gc/s	10 ... 1 cm
Extra high	e.h.f.	30 Gc/s and above	1 cm and less

The ionosphere may act as a reflecting layer for radio-frequency waves. The effective permittivity of the ionosphere is a function of ionization density and frequency. At low frequencies efficient long distance propagation is possible, the region between the earth and the lower regions of the ionosphere forming a duct of waveguide only a few wavelengths in height. At high frequencies the earth is distant from the ionosphere and the latter behaves as an isolated reflecting layer obeying the laws of geometrical optics and giving a reflected signal at a large distance. The properties of the ionosphere vary with frequency and at v.h.f. the ionosphere ceases to act as a reflecting layer under most normal conditions. In the medium frequency range absorption of energy can occur in the ionosphere and this reduces the possible range of propagation. This frequency range may be used for broadcasting using the ground wave over ranges of 100 miles or more.

At v.h.f., when the wavelength is 10 metres or less, there is little diffraction around the curvature of the earth and the transmitted energy may be radiated from aerials which are several wavelengths or more above the ground. In the line-of-sight region the total received wave may travel either by a direct ray path or by reflection at the earth's surface. The energy is travelling in the lower region of the atmosphere, the troposphere, in which most of the effects of weather take place and the propagation of the radio waves must be studied in relation to meteorological conditions. When high power transmitters and sensitive receivers are used at wavelengths of less than 1 metre it is found that signals may be received beyond the optical horizon at ranges of up to 600 miles. This is due to the scattering or reflection of a small part of the transmitted energy from irregularities in the refractive index of the air of the troposphere. At times the signal may reach values near to that which would be expected under free space transmission conditions. This is attributed to variations in the refractive index of the atmosphere which give rise to ducts in which the radio waves may be trapped over long distances.

Broadcast Receivers. - Neglecting crystal receivers, modern wireless sets can be divided into the two types now to be described:

"Straight" Receivers. - In these the RF signal induced in the aerial by the lines of an electro-magnetic wave cutting it, is first amplified, usually by one but sometime by two valves, without any change in wave-form, this being known as RF amplification, and is then demodulated by a detector stage. Here the RF component of the signal is suppressed by appropriate filters and the AF component is passed on to subsequent amplifying stages, which terminate in a valve which supplies sufficient audio-frequency power for the successful operation of a loudspeaker.

Superhet Receivers. - This type of receiver has now fully replaced the straight variety. In this receiver the signal from the aerial is mixed with another generated by an oscillator in the receiver itself. In large receivers some RF amplification is usually employed previous to the mixer stage. The mixing and oscillating is often done today by a single valve known as a first detector or frequency changer, although it was formerly the practice to use two valves for the purpose. One result of the mixing process is that a signal is generated whose frequency is the difference between that of the original signal and that of the oscillator, and which has impressed upon it the modulation of the original signal. This difference term is known as the intermediate frequency (IF), and it is a high inaudible frequency, popular values for it being 110 kc/s and 465 kc/s. The fact that the modulation is transferred to a new inaudible frequency has given this type of receiver its name, "Superhet" or "superheterodyne" being telescoped forms of "Supersonic Heterodyne".

HI-FI Amplifiers. - The equipment used for high fidelity reproduction usually consists of a gramophone motor and turntable, a pickup, a pre-amplifier with appropriate equalising networks, a power amplifier and one or more loudspeakers. If desired, a tape recorder and an f.m./a.m. tuner unit can also be incorporated.

Each one of these component parts contributes to the quality of the reproduction and to the amount of distortion introduced into it. At best they can do no more than reproduce faithfully the signal obtained from the source of sound, whether this be a recording on disk or tape, or a radio broadcast, in which a certain amount of distortion is certain to be present. Where this distortion is linear it can be wholly compensated by equalisation or by a tone control in the pre-amplifier or by both of these methods, but there is nothing that can be done to overdone all other forms of distortion at the source. The amplifiers, which form part of the link between the source and the listener, can have a very marked effect on the quality of the reproduction and, at the same time, they provide the only means, among the various component parts of the equipment, of varying the more important features such as the amount of amplification and the relative frequency response. It is not possible to vary the characteristics of loudspeakers, pickups, or recording and playback heads, but the controls in the amplifier enable us to match the whole of the reproducing system not only to the source, but also to the acoustical properties of the room, the personal tastes of the listener, and his auditory characteristics.

Quality Requirements for Hi-Fi Amplifiers. - Briefly the requirements to be imposed on a Hi-Fi amplifier are:

1. Low harmonic distortion (0.5 %).
2. Low intermodulation distortion (2%).
3. Low beat-note distortion (0.8%).
4. Linear response curve up to at least 1 octave above the audible frequency range, i.e. linear from 10 c/s to approximately 30,000 c/s.
5. Little phase shift within this range.
6. Low hum and noise levels (-52 to - 62 dB).
7. Sufficient output power to reproduce the loudest passages of music without noticeable signs of overloading.
8. Low output impedance to ensure electrical damping of the loudspeaker.

Feedback in Amplifiers. - In some special amplifier applications it may be desirable, or even necessary, to feed back a signal from the output of an amplifier to its input. This so-called feedback signal can be fed back in phase with the input signal, or out of phase with the input signal.

The Principle of Feedback. - A portion of the output signal is tapped off and fed back to the input circuit. The phase of this feedback determines the resultant output of the stage. If the feedback is in phase with the original signal, thus aiding it and increasing its amplitude, it is called positive or regenerative feedback. If the feedback is out of phase with the input signal, we have negative, or degenerative feedback. In general, negative feedback reduces the stage gain and, in practical circuits, is used to reduce distortion in the amplifier output and to improve the frequency response and stability of the amplifier. This process is termed neutralization, and it consists of feeding back a voltage that is opposite in phase and equal in amplitude to the voltage fed back through the interelectrode capacitances of the amplifier. As for regenerative feedback, it increases the gain of the stage, but also increases distortion. And, if the feedback is great enough, sustained oscillations will be produced.

ELECTRONIC COMPONENTS

The Cathode-ray Tube. - The cathode-ray tube is in a class by itself among the vacuum tubes. It consists essentially of a long evacuated glass tube at one end of which is generated a thin beam or pencil of electrons. At the other end of the tube is a thin screen of fluorescent material which glows under the impact of the electrons. If the beam is suitably concentrated or focused it can be made of relatively small diameter at the point where it strikes the screen so that its presence is indicated by a small sharply-defined spot of light.

The electron beam can be deflected by electrostatic or electromagnetic fields so that by the provision of deflecting sources operating in two co-ordinate directions the light spot can be caused to trace out a variety of patterns which can be employed for numerous engineering purposes. The movement of the beam is virtually instantaneous at all normal frequencies (below a few hundred Mc/s).

Transistor Materials. - As its name implies, a semiconductor has conduction properties midway between those of a metal and an insulator. A metal has a very low resistivity of the order of a millionth of an ohm cm because, as is generally accepted, there are many electrons available to carry a current. An insulator has a resistivity of many megohms cm because, as again generally accepted, there are few free electrons to carry a current. A semiconductor has a resistivity between these two extremes and the current is electronic in nature. It is important to remember that the current in a semiconductor can always be described by the movement of electrons only.

A transistor can be defined as a three-terminal semiconductor element capable of giving an a.c. power gain when connected in a suitable circuit. This differentiates it from, say, a transformer, which can give either a voltage or a current gain but always a power loss.

Of all the semiconductors, only germanium and silicon are used in the manufacture of transistors on a commercial scale and it is unlikely that they will be superseded.

Microminiaturization. Microcircuit or Twodimensional Techniques. - First, let us consider the basic concepts underlying microminiaturization. A good quality resistor may consist of a thin track of resistive material on ceramic or glass. Most of the volume of the resistor is occupied by the case, which may be 500 times the volume of the active element. Similarly, the volume of the active element of a capacitor is several hundred times smaller than the surrounding case. A transistor is very small compared with a thermionic valve, but even so, most of its volume is occupied by the case, the semiconductor active element being only a fraction of the total. As an example, the volume of the active element of a small-signal transistor is only about 10 mm^3 or less. Similar considerations apply to a semiconductor diode, for here again the active element is much smaller than the case.

It will now be appreciated that one way of reducing the size of an electronic assembly is to get rid of the cases of the individual components. This is not a straightforward procedure because the cases are there for two very good reasons: first, to support the active part of the component and secondly, to protect the active part from damage and the effects of noxious ambients. The problem has been tackled in three distinct ways, giving rise to three systems of microminiaturization. These are microcircuits, or two-dimensional techniques, micromodules, and solid circuits, or three-dimensional techniques.

Essentially, a microcircuit is a flat insulating plate or substrate on which are deposited, or recessed, the active elements of resistors, capacitors, diodes and transistors. There are several alternative ways in which these component parts can be made or deposited.

Resistors may be made from various materials and in different ways. The zig-zag pattern is often called a meandered resistor.

Capacitors can be made integral with the substrate, that is, the substrate may be the capacitor dielectric. In that case, there will be a large-area low-resistance film on each side of the substrate. Capacitors may also be made by evaporation or sputtering processes. When all the component parts have been produced on or in the flat substrate, several units may have to be connected together in a suitable manner. The final stage is to seal the assembly hermetically.

Solid Circuits or Three-dimensional Techniques. - The last of the three systems of microminiaturization to be described has a variety of names; solid state circuits, solid circuits, microelectronics, molecular engineering, molecular electronics, functional electronic blocks, molectronics, semiconductor networks and others. In this chapter, the term "solid circuit" will be used.

The solid circuit technique of microminiaturization is more complex than the microcircuit and micromodule systems. However, provided the elements of semiconductor theory are known, solid circuits can be explained quite readily.

Semiconductor solid circuits are electronic devices formed in single crystal wafers of semiconductor. Each wafer performs the function of some standard circuit that uses several conventional active and passive components. Paths are fashioned on and through each wafer to produce active elements such as transistors, non-linear elements such as semiconductor diodes, and passive elements such as resistors, capacitors and distributed parameter networks. By changing the types of paths and their routes, an unlimited variety of circuits is possible. These circuits give the greatest reduction of size and weight of any of the microminiaturization systems so far described.

The present higher cost of solid circuits compared with assemblies of individual units suggest applications in which there is a large premium on weight and space. Thus, solid circuits are especially suitable for digital circuitry, particularly where the computer has to be small and, possibly, mobile. Digital circuits are usually repetitive, which permits the construction of large systems with only a few basic building blocks.

Solid circuits are, without doubt, the most promising form of microminiaturization. The techniques are comparatively new, and the work done so far must be regarded as only laying the foundations of a form of circuit building which may eventually revolutionize electronics. Solid circuits, being formed in single blocks of semiconductor, have advantages over the other microminiaturization systems in that they do not require a sequence of diverse fabrication steps, have few contacts between dissimilar metals, suffer less from the effects of differential thermal expansion, and are relatively easy to heat sink. Thus, the future of solid circuits seems to be assured.

MASERS. - The "maser" is an amplifier or oscillator which operates by induced emission. The fundamental principles were known to all twentieth century physicists. To actually obtain amplification, considerable detailed knowledge of specific materials and techniques were needed. The fundamentals are briefly discussed in the following:

Atoms and molecules exist in certain energy levels or states. For an isolated atom to alter its state it must absorb a photon from an electromagnetic wave or it may emit a photon. This situation results from the principles of conservation of energy and momentum. Suppose first, that the atom is in an upper energy level. When it "sees" an electromagnetic wave of the proper frequency and in the appropriate direction, it is induced or stimulated to emit a photon and drop to an available lower energy level. The wave does not lose energy by virtue of the stimulation, and it gains the energy of the emitted photon. This process occurs all around us since light waves are forever interacting with matter. At the same time, matter also gains energy; atoms absorb photons and become excited. Consequently, there is no net amplification process for the photons in nature.

In a quantum-mechanical amplifier, the absorption process must be eliminated or reduced relative to the emission process. We may accomplish this with a collection of molecules which are all in the upper energy level. This, however, is not easy to obtain. It is important to note that light and radio-frequency waves are identical except in frequency. Light waves are about a hundred thousand times higher in frequency than microwaves. As a result, the rules of induced emission and absorption apply equally to both types of waves. Thus it is the induced emission principle (using microwaves) that results in amplification.

Holograms. - An exciting display technique that is arousing great interest is the use of holograms for three-dimensional imagery. Holograms are not new; they were first investigated back in 1948. However, until lasers appeared, the holograms which were made were of extremely low intensity, and therefore quite impractical. For those unfamiliar with holograms, they are simply photographs of interference patterns. The interference pattern is formed by combining an unscattered coherent light beam with the light from the same coherent source scattered from objects in the field of view. The phase information in the interference pattern provides a measure of the distance of a point on an object in the field of view to another point on the same or different object. If coherent light is projected through the hologram, the original object is reconstructed in space. We obtain a three-dimensional image from the two-dimensional hologram. Some of the effects of reconstituting a hologram are startling. For example, the parallax effect - observed by moving the head around to change the angle of viewing - discloses objects hidden behind foreground objects that hide them when seen from other angles.

Since the interference pattern can be photographed or can be observed on a ground-glass screen, it could also be picked up by an image orthicon.

For the television output display, the photographic film used in present day holography would also have to be replaced by an absorbing (or scattering) surface which could be continuously varied. Photocromic and thermoplastic materials have this property but currently suffer from the difficulty of having only limited life. It is hard to say whether or not this limitation can be overcome in either of these materials, but it is safe to state that such an innovation, if successful, would drastically affect the television display industry.

Physical Characteristics of Picture Tubes. - The tubes used in transistor television receivers, as in valve sets, employ electromagnetic deflection. Beam deflection is achieved by current supplied to deflection coils situated around the neck of the cathode ray tube.

In transistor as in valve television set practice, direct-viewed screens are the rule. A few projection or indirect-viewed receivers may be found, but these are the exception. The size and physical shape of the television cathode ray tube is decided by a number of factors. These are:

(a) screen diameter, (b) deflection angle, (c) neck diameter, and (d) overall length.

The modern valve trend to rectangular, rather than round, tube faces is followed in transistor sets. All the commercial receivers have used rectangular screens.

Over the years, the screen diameters of picture tubes in valve sets have gradually increased. With the increasing use of larger screens, rectangular tubes have been produced with different diameters. In valve sets, the only objections to larger and larger screens have been cost and visibility of line structure. There is no insurmountable technical barrier. In transistor television receivers the position has been a little different. Commercial transistor receivers so far have tended to be battery or battery-mains sets. The use of large screens requires greater power than can economically be supplied by currently available batteries or rechargeable cells. Thus the requirement for battery operation has tended to limit screen sizes. With the constant reduction in size of electronic components, the length of the picture tube is now the main limitation to reducing cabinet depth. For a given size of picture, the tube length can be reduced in two ways, either by shortening the tube neck or by increasing the deflection angle. In modern tube practice the tube neck is as short as possible and shallower cabinets can be achieved only by increasing the deflection angle. In valve sets this has led to a progressive increase of the tube deflection angle from 50° through 70° and 90° to 110°; the last has become almost standard now. The main disadvantage of the wide-angle deflection tube is that it calls for such great scanning power. In mains-driven valve sets the provision of this extra power is not a major difficulty, but it has proved a serious problem in transistor sets. As a result, the tendency in commercial transistor sets so far has been to use 90° tubes.

QUESTIONS

1) Which are the two chief types of broadcast receivers dealt with in the text?
2) What is the fundamental difference between a straight receiver and a superhet?
3) Which are the characteristic features of a superheterodyne receiver?
4) What do cathode-ray tubes used in the field of electronic measurement essentially consist of?
5) By what kind of fields can the electron beam be deflected?
6) How is beam deflection achieved in transistor television receivers?
7) Which are the main significant dimensions of a tube?
8) What limits screen sizes in portable TV receivers and what are the objections to larger and larger screens in valve sets?
9) In what way can the length of picture tubes be reduced?
10) What is the main disadvantage of a wide-angle deflection tube?
11) Name some of the most important physical characteristics of picture tubes.
12) What does the word "maser" mean?

IMPORTANT TERMS

aerial ('ɛəriəl) (US: antenna)	-	Antenne f
angle of viewing	-	Sehwinkel m
beam deflection	-	Strahlablenkung f
brilliance	-	Helligkeit f
cabinet	-	Gehäuse n
capacitor	-	Kondensator m
case	-	Hülle f, Hülse f, Kapsel f, Gehäuse n
coherent (kəu'hiərənt)	-	kohärent, zusammenhaftend
deflection coils	-	Ablenkspulen f/pl
deflector plate	-	Ablenkplatte f
detect, to	-	(radio) gleichrichten; (radar) auffassen, erfassen
detector	-	Suchgerät n; Messzelle f, Messfühler m; Anzeigevorrichtung f, Indikator m
detector stage	-	Demodulationsstufe f, Demodulatorstufe f
digital circuitry	-	Digitalschaltung(en) f/pl, Digitalschaltungsanordnung f
direct-viewed screen	-	Bildschirm m mit direkter Bilddarstellung, Direktsichtbildschirm m
disclose, to	-	enthüllen, ans Licht bringen, erschliessen
display	-	Sichtteil m; Anzeige f, Sichtanzeige f
display technique	-	(optisches) Wiedergabeverfahren
distributed parameter	-	verteilter Parameter
electron gun	-	Elektronenstrahlerzeuger m, Elektronenkanone f
electronics	-	Elektronik f
energy level	-	Energieniveau n
extremity	-	das äusserste Ende, Spitze f

feature, to	-	aufweisen, besitzen
feed back, to	-	rückkoppeln
feedback	-	Rückkopplung f
degenerative feedback	-	Gegenkopplung f
negative feedback	-	negative Rückkopplung
positive feedback	-	positive Rückkopplung
regenerative feedback	-	Mitkopplung f
field of view	-	Gesichtsfeld n
fluorescent lamp	-	Leuchtstofflampe f
fluorescent screen	-	Leuchtschirm m, Fluoreszenzschirm m
ground-glass screen	-	Mattscheibe f
heat sink, to	-	Wärme ableiten, Wärme abführen, kühlen
hologram ('hɔləgræm)	-	Hologramm n
image orthicon	-	Orthicon n, Fernsehkamera f
imagery	-	Bilder n/pl, Abbildung f, Bildentwerfung f, Bilderzeugnung f
innovation	-	Neuerung f, Neugestaltung f
interference pattern	-	Interferenzbild n
large-area	-	grossflächig
loudspeaker	-	Lautsprecher m
low-resistance	-	niederohmig
mains-driven receiver	-	Netzempfänger m, Netzanschlussempfänger m
meander-shaped	-	mäanderförmig
meandering (mi'ændəriŋ)	-	gewunden, schlangenförmig
microcircuit ('maikrou ...)	-	Mikroschaltung f, Dünnfilmschaltung f
microminiaturization	-	Mikrominiaturisierung f
miniaturization	-	Miniaturdimensionierung f
neck	-	Hals m
network	-	Netzwerk n, Netz n
open balanced transmission line	-	offene, (nicht abgeschlossene) symmetrische Uebertragungsleitung

path	Weg m, Bahn f, Pfad m, Strecke f
photon	Photon n, Lichtquant n
pick up, to	aufnehmen, auffangen, empfangen, erfassen, auffassen
picture tube	Bildröhre f
playback head	Wiedergabekopf m
quantum-mechanical	quantenmechanisch
radio-broadcast, to	über den Rundfunk senden
radio broadcast	Rundfunk m, Rundfunkprogramm n
radio-broadcasting station	Rundfunkstation f, Rundfunksender m
radio communication	Funkverbindung f, Funkverkehr m, Funkübertragung f
radio frequency	Hochfrequenz f
recess (ri'ses)	Aussparung f, Vertiefung f
recessed	versenkt
recharge, to	wieder(auf)laden, nachladen
recording chart	Registrierpapier n
recording head	Aufnahmekopf m, Aufzeichnungskopf m
scanning power	Ablenkleistung f
scattered beam	Streustrahl m
scattering	Streuung f
screen	Bildschirm m
solid circuit	Festkörperschaltung f, aus einem einzigen homogenen Halbleiterblock bestehende Schaltung
solid state	Festkörperzustand m, Festkörper ....
solid-state physics	Festkörperphysik f
spot	Fleck m, Leuchtpunkt m
sputtering ('spʌtəriŋ)	Zerstäuben n, Zerstäubung f, Kathodenzerstäubung f

straight receiver	-	Geradeausempfänger m
substrate ('sʌbstreit)	-	Substrat n, Träger m, Schichtträger m, Basis f, Basisplatte f
television display industry	-	Fernsehgeräteindustrie f
television output display	-	Fernsehbildwiedergabe f
three-dimensional	-	dreidimensional, 3-D-, räumlich
valve set	-	Röhrenempfänger m
visibility	-	Sichtbarkeit f, Sicht f
wafer ('weifə)	-	Blättchen n, Scheibchen n
wide-angle deflection	-	Weitwinkelablenkung f

GRAMMAR and NOTES

1. The amplifiers, which form part of the link between the source and the listener, can have a very marked effect on the quality of the reproduction ...

Die grundsätzliche Unterscheidung zwischen bestimmenden und erläuternden Relativsätzen ist für das Englische deshalb wichtig, weil sich die beiden Arten der Relativsätze hier durch ihre Form unterscheiden.

Bestimmende Relativsätze (Defining Relative Clauses) werden mit dem Hauptsatz ohne Komma verbunden. An ihr Beziehungswort schliessen sie sich ohne Sprechpause an. Die gesprochene Sprache verwendet nahezu ausschliesslich diese Art der Relativsätze.

The pencil _ that is lying on the table _ is a very good one.
Der auf dem Tisch liegende Bleistift ist ein sehr guter.

His brother _ who lives in London _ is seriously ill.
Sein Bruder, (und zwar derjenige,) der in London lebt, ist schwerkrank.

Erläuternde Relativsätze (Non-defining Relative Clauses) werden sinngemäss durch Sprechpausen, und dementsprechend in der Regel durch Kommasetzung, vom Hauptsatz abgehoben. Hier gibt der Relativsatz lediglich eine beiläufige Bemerkung oder Erläuterung.

Erläuternde Relativsätze finden sich vor allem in der Literatursprache.

My new pencil, which now is lying on the table, is a very good one.

Mein neuer Bleistift, der im Augenblick (übrigens) auf dem Tisch liegt, ist sehr gut.

His eldest brother, who lives in London, is seriously ill.

Sein ältester Bruder, der (nebenbei bemerkt) in London lebt, ist schwerkrank.

Schematische Uebersicht
über die im heutigen Englisch jeweils bevorzugten Relativkonstruktionen

A. bei bestimmenden Relativsätzen (im Objektskasus die Kontaktkontruktion, d.h. ohne Pronomen angeschlossen)

	Personen	Sachen
Subjektskasus:	... who ...	... that (or: which)
Objektskasus:	... _ ...	... _ ...
Objektskasus + Verhältniswort:	... _ ... + Verhältniswort	... _ ... + Verhältniswort
possessiv:	... whose ...	... of which ... (... whose ...)

B. bei erläuternden Relativsätzen (in der Umgangssprache wenig gebräuchlich):

	Personen	Sachen
Subjektskasus:	..., who ...	..., which ...
Objektskasus:	..., whom ...	..., which ...
Objektskasus + Präposition:	..., Präp. + whom ...	..., Präp. + which ...
Possessiv:	..., whose ...	...,... of which ... (..., whose ...)

2. Digital circuits are usually repetitive, which permits the construction of large systems with only a few basic building blocks.

Which bezieht sich auch als einziges Relativpronomen auf einen vorhergehenden ganzen Satz. Es entspricht darin einem deutschen "was":

He said that he had seen me then, which I could not believe.

Er sagte, er habe mich damals gesehen, was ich nicht glauben konnte.

3. Anmerkungen:

1) metre - das Meter (US - meter). Der Ausdruck "meter" ist Synonym zu "measuring instrument".

2) transmitter - in der Regelungstechnik mit "Geber" oder "Messwertübertrager" zu übersetzen, ebenso als "Geber" in der Telegraphie.
In radiotechnischen Texten heisst transmitter "Sender". Verb: to transmit = senden, übertragen

3) neglecting - sog. "dangling participle", aufzulösen zu: "if we neglect ..." (falsch bezogenes Partizip)

4) straight receivers - werden in der Fachliteratur auch als "TRF-Receivers" (Tuned Radio Frequency Receivers) (Geradeausempfänger) bezeichnet

5) for the successful operation of a loudspeaker - ... um einen Lautsprecher mit der nötigen Leistung betreiben zu können

a) to operate (ansprechen, arbeiten, bedienen, betätigen, betreiben, laufen, verarbeiten)

- Wie "to control" deckt dieses Wort einen weiten Bedeutungsbereich und ist jeweils entsprechend zu übersetzen. Beachten Sie folgende Möglichkeiten:

energy for operating lights - ... für Beleuchtungszwecke

energy for operating home appliances - ... zum Betrieb von Haushaltgeräten

operating features - Betriebsmerkmale, Kennwerte, Betriebsparameter

operating temperature - Betriebstemperatur ... when the cells are inoperative - ... wenn die Batterien nicht arbeiten

light-operated burglar alarm - photoelektrische Einbruchssicherung operator - allg. Arbeiter an einer Maschine; spezifischer aber: telephone operator - Telephonist(in)

principle of operation - Arbeitsweise (einer Maschine). Dagegen die "Arbeitsweise eines Menschen, einer Abteilung, eines Gremiums" heisst "practice"

successful operation - einwandfreies Funktionieren

operates on the signal ... - spricht auf das Signal an

b) to control - steuern, regeln, regulieren; bedienen, betätigen, schalten

Das Substantiv "control" hat u.a. folgende deutsche Entsprechungen: Steuerung, Regelung, Regeleinrichtung, Bedienungselement, Regler, Schalter, Bedienung, Betätigung.
Beachten Sie: "a controlled amount" - eine genau festgelegte, definierte Menge.

6) basic construction - Prinzip. Beachten Sie auch:

basic - "Grund-" (The basic law in electric circuit theory is Ohm's law.)

base - Basis, Grundlage, Sockel ... (The base of common logarithms is 10. The machine rests on a firm base.
Rocket base (mil.) - Raketenbasis; relay base (US) - Relaisstation

basis - Basis, Grundlage (This theory requires a better factual basis.)

to base / to be based on - gründen, beruhen auf (This device is based on a recent discovery.)

7) whether this be a recording on disk or tape - "be" ist hier Konjunktiv des Präsens. In Nebensätzen wird der Konjunktiv des Präsens verwendet, um die Aussage nicht als Tatsache, sondern als blosse Annahme oder Vermutung hinzustellen.

8) A certain amount of distortion is certain to be present - Es tritt bestimmt eine gewisse Verzerrung auf. Analoge Bildungen sind auch mit "likely" und "sure" möglich (z.B. His experiment is likely to be successful.)

9) say - zum Beispiel; etwa, ungefähr (bei Zahlenangaben)

10) broadly speaking - allgemein gesagt

11) tube, electron tube - Elektronenröhre; die Bezeichnung "electronic valve", in der älteren Literatur noch häufig anzutreffen, wird immer mehr von "tube" verdrängt, das von der ISO (International Standardizing Organization) empfohlen wurde. "Valve" wird in der Bedeutung "Ventil" in der Regelungstechnik verwendet: "Any device for closing or modifying the passage through a pipe, outlet, inlet or the like." Für die Steuerung und Regelung hydraulisch betriebener Systeme (hydraulic-powered systems) ist "valve" der Oberbegriff und kann je nach Kontext "Ventil", "Schieber", "Steuerventil" u.a.m. bedeuten.

12) to provide (versehen, versorgen, ausstatten, (be)liefern, verschaffen, besorgen). Die Uebersetzung von "to provide" richtet sich nach dem jeweiligen Kontext. Beachten Sie daher folgende Uebersetzungsmöglichkeiten:
Both focusing and deflexion can be provided by magnetic means ... -
Sowohl die Fokussierung als auch die Ablenkung können magnetisch erfolgen ...
Beyond the anode is the focusing field, provided either by a permanent magnet or by an electromagnet. -
Hinter der Anode befindet sich das entweder von einem Permanentmagneten oder von einem Elektromagneten gebildete (aufgebaute) Fokussierfeld.
... again providing a sharply defined spot of light. -
... wo sie wieder einen scharf umrissenen Leuchtfleck bilden.
... magnetic focusing is preferable as it provides a more uniform focus ... -
... ist die magnetische Fokussierung vorzuziehen, da sie eine bessere Schärfeverteilung bietet.
to provide the power requirements of a satellite -
einen Satelliten mit Energie versorgen
to provide a continuity of power for - die kontinuierliche (ununterbrochene) Stromversorgung gewährleisten.

Beachten Sie auch:

by the provision of - mittels, durch

to be provided for - vorbereitet sein auf

provided (that) - vorausgesetzt, unter der Voraussetzung oder Bedingung, dass ...

13) a turn of the winding of a coil - eine Windung der Wicklung einer Spule

14) a voltage is applied - eine Spannung is/wird angelegt

15) A transistor transfers a voltage across a resistor. -
Die Zusammenrückung ist ein im technischen Englisch nicht selten benutztes Mittel für die Bildung neuer Begriffe und Benennungen:
molectronics = molecular electronics;
paramp = parametric amplifier

16) ... in the manufacture of transistors on a commercial scale - in einem für den Handel wesentlichen Umfang; oder: bei der Herstellung handelsüblicher (kommerzieller) Transistoren

17) for ease of presentation - zur Vereinfachung der Darstellung

18) maser - microwave amplification by stimulated emission of radiation (Mikrowellenverstärkung durch angeregte Emission von Strahlung)

19) laser - light amplification by stimulated emission of radiation (Lichtverstärkung durch angeregte Emission von Strahlung)

20) to actually obtain ... - um tatsächlich ...zu erreichen (sog. "split infinitive", relativ selten)

21) principles of conservation of energy and momentum - Energie- und Impulserhaltung

22) there is no net amplification process - es gibt keinen wirksamen (resultierenden) Verstärkungsprozess

23) for those unfamiliar with holograms - Diese stark komprimierte Aussage muss sinngemäss ergänzt werden: Für alle jene, die mit Hologrammen nicht vertraut sind, sei zur Erklärung gesagt, ...

24) Prägen Sie sich ein:

a) to close (klouz) - abschliessen, verschliessen, schliessen
(The container was closed hermetically.)

close (klous) Adj. - dicht, nahe, eng, knapp

close to (with) - dicht bei, unmittelbar an, ganz in der Nähe von
(The heater was placed close to the emitter.)

b) ray - (Einzel)strahl

bundle of rays - Strahlenbündel, Strahlenbüschel

beam - Strahl

beam of rays - Strahlenbündel

beam of light - Lichtstrahl

pencil - Strahlenbündel, Strahlenbüschel

pencil of light - Licht(strahlen)bündel

c) current (Substantiv) - electric current - elektrischer Strom

alternating current - Wechselstrom

direct current - Gleichstrom

current intensity }
current strength } - Stromstärke

current (Adjektiv) - current affairs - Tagesereignisse

current research on semiconductor materials - die laufenden (gegenwärtigen) Forschungen über Halbleitermaterialien

to be in current use - allgemein üblich, gebräuchlich sein

d) tension - Zugkraft, Spannkraft, Spannung (mechanisch); Spannung (elektrisch). Zum Beispiel: High-tension cable, high-tension generator, high-tension engineering, extra-high tension

voltage - Nur "Spannung" (elektrisch). Zum Beispiel: Voltage change - Spannungsänderung; voltage amplifier - Spannungsverstärker, Vorverstärker; selten: high voltage - Hochspannung

potential - Spannung (elektrisch). Zum Beispiel: Potential coil - Spannungsspule; potential drop - Spannungsabfall; potential to puncture - Durchschlagsspannung

stress - Spannung, Beanspruchung (mechanisch). Zum Beispiel: bending stress - Biegebeanspruchung, dynamic stress - dynamische Belastung

Beachten Sie: In elektrotechnischen Texten ist "voltage" der am meisten verwendete Terminus für "Spannung". Das gilt auch für Zusammensetzungen vom Typ "voltage change" (Spannungsänderung). Einen Sonderfall stellen die Zusammensetzungen mit "Hoch- oder Höchstspannung" dar. Hier dominiert "tension". Der Terminus "Spannungsanzeiger" kann mit allen drei Wörtern gebildet werden, also "tension indicator", "voltage indicator", "potential indicator".

e) at some length - ziemlich ausführlich
at great length - sehr ausführlich

f) synonyme Wendungen:

darum deshalb infolgedessen	that is why; as a result; therefore; for that reason; consequently; hence; thus, because of that; on account of that
sich herausstellen als, sich erweisen als	to prove to be; to turn out to be; to be found to be
(er)fordern, verlangen (nach), benötigen	to call for, to require, to need, to demand
ausgleichen	to compensate, to make good

g)

Institute of Technology (s.S.441)	Technische Hochschule
Technical University	Technische Universität
Technical High School	Gewerbeschule (US)
Technical School	(Poly)Technikum
School of Engineering	Technikum, HTL

h) 1) above (adv.) - darüber. The book is concerned with propagation at v.h.f. and above.

2) above (prep.) - über: the height above the surface of the earth

25) technician = highly skilled craftsman or mechanic; expert in the techniques of a particular art

technique (tek'niːk) = a method used by an expert; method of doing something; technical or mechanical skill in art, music etc.

technics ('teknɪks) = 1) Those branches of knowledge dealing with mechanical or industrial arts.
2) technical terms, details, methods etc.

technology = the science which deals with industrial arts.

technologist = one who has studied technology

engineering = the science of building and controlling machines, ships, roads, etc.; the profession of an engineer. Engineering is studied at a school of technology.

engineer = 1) a person who studies, plans and builds machines, ships, docks, roads, bridges, forts, etc. as a civil (mining, electrical, military, sanitary, etc.) engineer.
2) a person who has charge of engines, as the chief engineer of a ship (i.e. the chief officer in charge of the engines); (in U.S.A.) a man who drives an engine on a railway (cf. Eng.engine-driver).
3) a member of that part of an army that builds roads and bridges, controls telegraphs and telephone communications, builds forts, etc.

technical (adj.) = 1) having to do with one of the mechanical or industrial arts or an applied science, as a technical school (where such subjects as engineering, architecture, chemistry and mechanics are taught); technical terms and expressions (i.e. those used and understood by persons having a special knowledge of a particular subject).

2) connected with the methods employed by experts in a particular branch of activity. A pianist may have technical skill but no inspiration.

3) from the point of view of an expert or inventor, as technical difficulties.

technically (adv.)

technicality = 1) a point understood only by experts. The two architects are discussing building technicalities.

2) a detail to which experts attach too much importance.

technicist = technician

Engineering ist das zutreffende Aequivalent für den Ausdruck Technik oder (je nach dem Zusammenhang) Technologie. Während mit dem Wort engineering die Technik als Ingenieurwissenschaft gekennzeichnet wird, weist das Wort technique auf ihre betriebstechnische Anwendung hin (Arbeitsweise, Methode, Betriebsweise, technisches Geschick, Kunstfertigkeit, Technik [in ihrer praktischen Anwendung]).

EXERCISES

1. Insert the correct relative pronouns:

1) It is the output stage .... should provide sufficient power to guarantee realistic reproduction of orchestral music. 2) It is the electrical engineer .... designs and constructs electrical devices. 3) The amlifiers, ... form part of the link between the source and the listener, can have a very marked effect on the quality of the reproduction. 4) It is the amplifier .... is the only means of control or adjustment in any Hi-Fi equipment. 5) There is nothing .... can be done to overcome these forms of distortion at the source. 6) This is a reproduction .... a discerning listener can be satisfied with.

7) We obtain the signal from the source of sound, in .... a certain amount of distortion is certain to be present. 8) The electrical apparatus .... you are using might become "alive". 9) Each of the component parts .... a Hi-Fi equipment consists of contributes to the quality of reproduction.

2. Put in suitable prepositions:

1) The reader is familiar .... this principle. 2) The principle is familiar .... the reader. 3) What is a cathode-ray tube used .... ? 4) The electron gun is .... the left-hand end of the tube. 5) The choice of the system is determined .... engineering considerations. 6) The tube consists .... an evacuated glass tube .... one end of which is generated a thin beam of electrons. 7) In a room the bounding surfaces confine the sound energy .... the space they enclose. 8) The room must be used .... the purpose .... which it is designed. 9) This form can be applied .... a large number of systems. 10) One of the desirable qualities is freedom.... troublesome echoes. 11) Their judgment is based .... subjective experience. 12) Rooms whose acoustic qualities are important can be divided .... two classes. 13) Resonance or fullness of tone is also described .... various other terms. 14) The required sound distribution depends .... subjective experience.

3. Translate into English:

1) Diese Methode ist hier nicht anwendbar. 2) Diese Schaltung enthält einen zusätzlichen Verstärker. 3) Das Gerät, das für Hi-Fi-Wiedergabe verwendet wird, soll das Signal wahrheitsgetreu wiedergeben. 4) Lineare Verzerrung kann gänzlich ausgeglichen werden. 5) Die Verstärker haben eine grosse Wirkung auf die Qualität der Wiedergabe. 6) Diese Art der Rückkopplung wird als positive Rückkopplung oder als Mitkopplung bezeichnet. 7) Die Abmessungen werden in jeder Abbildung angegeben. 8) Verglichen mit einer Elektronenröhre ist ein Transistor sehr klein. 9) Das Gehäuse schützt das aktive Bauelement vor Beschädigung.

ELECTRONIC DATA PROCESSING

(American)

History of Data Processing. - Computer manufacturers are constantly trying to develop computers with a longer life and of a smaller size capable of storing more data and operating at greater speed.

In 1943, there were no electronic computers available. Ten years later, many electronic calculators were commercially available, but the general-purpose, stored-program electronic digital computer was not widely used. Between that time and 1958, hundreds of vacuum-tube computers were put into operations. Most of the small-size to medium-size models had magnetic drum storage, while only the largest computers contained magnetic core storage. In 1959, the use of vacuum-tube computers almost ceased when transistorized computers began to appear on the market. Since their appearance, thousands of transistorized computers have been delivered and installed.

Computers are generally classified as small-, medium-, or large-scale. This classification is not necessarily an indication of their physical size, but rather is used as a general price-scale categorization. In recent years, the trend has been toward producing medium-scale computer systems. The larger, more powerful computer systems have been used primarily for scientific and engineering purposes. Current and future trends may very likely move toward the production of small-scale computers, especially since electronic data processing has made a powerful appeal to the small businessman.

AUTOMATIC DATA PROCESSING IN THE SCIENTIFIC WORLD

In the past, many scientific problems were left unsolved because of the seemingly impossible task of processing a variety of complex formulas by manual methods. The present use of automatic data processing has given the scientist and engineer tools with which to handle such involved computations.

Problems that would have taken a lifetime of calculations in the past now are being processed by computers in a matter of minutes. Some problems with a large number of variables and restriction could never have been handled by ordinary means; today computers process them with comparative ease. With the new tools of automatic data processing, scientists in both basic and applied research have widened their horizons and have given new freedom to creative thought.

What is Scientific Data Processing? - Scientific data processing consists mainly of solving mathematical problems such as engineering formulas, research and development problems, or any type of calculation that normally requires a "one-time" solution. Unlike most business problems, scientific problems are generally not repetitive.

The scientist and engineer must solve problems with many variables, dealing with probabilities, statistical equations, and so on. This presents a different kind of problem for the computer than the typical business application, which usually involves a high volume of input and output, but limited arithmetic requirements. Consequently, scientific and business computers have generally been different in design, despite the fact that many so-called business computers are being used for certain scientific and engineering applications. The reverse is also true in a few cases.

Although scientific data may differ from business data, the pattern of processing is quite similar. First, a system must be devised. Second, a problem must exist that can be represented in a form acceptable to the data-processing system.

As tools for the engineer, computers are one of the vital elements in the field of automation. They have been linked to metal-working tools, production mills, and processing plants. Some computers are even being used to design other computers planning the wiring circuitry and issuing instructions to the automatic equipment which physically wires the circuits.

Through the use of a device called a plotter, which may be connected to a computer, charts and graphs may be produced. By the introduction of engineering specifications into such a machine, mechanical drawings can be created.

INFORMATION FLOW

As used here, information flow refers not only to the movement of data or information but to the entire cycle of collecting, converting, storing, processing, and producing information. It is especially concerned with the ultimate utilization of this information either as a basis for decision or action or as an input to another system or activity. There is little doubt that the success of a particular application depends heavily on a thorough knowledge of the information flow during the planning stage. Yet this knowledge is not easy to come by. It is the fruit of hard work, patience, and insight.

It should be noted that the detailed pattern of information flow is unique for every problem. This is why it is so important for users to be involved in this part of the planning. The information flow is unique because the quantity, quality, and time factors associated with each type of data are part of the information flow. Even the decision rules must be considered. For instance, there are hundreds of inventory control problems in different industries and government agencies. From an overall viewpoint these are essentially one application. Yet the information flow for each one will be different. The information flow is tied in with the peculiarities of each organization, with the particular operating environment, and sometimes even with the personalities of certain key individuals.

Characteristics of Information. - Although we convey "information" in some physical form (printed words, sounds, punched cards), the information itself is not tangible. Yet it is something that is very real. In a sense, the information is there - it exists - even if we didn't bother to measure it or record it.

Even though we can't "see" or touch the information, it does have attributes. We can develop measures of the "quantity" of information in a message for instance. Or we can speak of the qualities of specific information - its timeliness, accuracy, availability, and reliability. We can speak of the value of certain information or the cost to gather, process, or store it. In planning computer systems, it is important to adopt an attitude toward information - to treat it as a commodity, a raw material, a product, or a link between events.

We start by defining an item of information as the smallest unit of information which has informational value and attributes. Examples of this are a date, an individual's name, or the distance between two locations. Such items of information seldom occur alone in an information system but are usually grouped together in messages or records just as English words are normally put together in sentences. Although a single English word conveys some meaning, it is more valuable - conveys more meaning - within a sentence. So it is with an item of information in a computer system. For many information systems the basic input record or message is called a transaction. This is a complete unit of information which refers to some event, decision, or request. The transaction usually contains many items of information used to describe the event. These items are of two types: the identification data and the content or substance of the record. For instance, a routine payroll "transaction" would be the weekly report for a particular individual. As identification, this transaction would include the type of transaction, the employee's name or number, the date, and the department number. The content would be a breakdown of hours worked according to various job numbers. A different type of transaction in the same system would be a change in the employee's pay status. This would probably involve different identification data and different content. For each transaction it is important that the identification information be adequate to permit retrieval of the content of association of the content with that of other transactions.

Such transactions are the raw material for an information system. Individually or sollectively the transactions trigger off a chain of events within the system. The information in a transaction is usually edited or tested, perhaps transcribed into other forms, filed in one or more locations, compared with other information, and used as a basis for decisions, reports, or actions.

In many cases the information attributes (timeliness, accuracy, etc.) are vitally important and should be retained with the information as it flows through the system and should be reflected in the outputs produced by the systems.

COMPUTER APPLICATIONS. OPEN-LOOP AND CLOSED-LOOP SYSTEMS

For an open-loop system, data gathered from a physical source are not used to affect that process. Weather forecasting and reporting of returns of political elections are examples. They are open-loop in that we wish to know about the weather and the elections, but little, if anything, can be done to change or alter them. The output from the data processing operations may influence our actions or satisfy our curiosity, but they are never used to change the process that supplied the data.

We will use weather forecasting as an example of the operations of open-loop systems. Weather stations, as data sources, are distributed over the earth where measurements of such conditions as temperature and barometric pressure are made.

The data-input operations are (a) measuring and recording of data, (b) transmission of data to the processing center, and (c) data preparation for processing on a computer. When any, or all, of these serial operations are performed manually, the computer performing the data processing operations is called "off-line". If the data from the sources enter the computer directly without human intervention, the computer is called "on-line".

The output operations are (a) preparation of computer output for transmission, (b) transmission of output, and (c) preparation of output for application at the destinations - the homes of people who want the weather forecast. When any, or all, of these serial operations are performed manually, the computer producing the output is "indirectly connected" to the output destinations. If the output of the computer reaches the output destinations directly without human intervention, the computer is "directly connected" to the output destinations.

An important value to determine for this type of system is the interval of time, beginning when a value of a condition, such as wind velocity, is read, and the earliest time the calculated output which requires that value, reaches the destinations. This interval of time is called "time delay". The longest time delay is for the conditions of the computer operating off-line and indirectly connected to the output destinations; the shortest time delay is for the conditions of the computer operating on-line and directly connected. For these conditions the time delay is so short that it is negligible, and the systems is referred to as a "real-time" system.

The three operations of data input, data processing and output are also performed in closed-loop systems, but for this type of system the information of output is returned to the process where it may cause changes in those process operations. The process and the computer then form a closed-loop through the communication channels.

The launching of a satellite is an excellent example of a real-time system, where events are happening so fast that only the great speed of the computer makes closed-loop control possible. In this situation delicate instruments monitor the performance of all parts of the rocket system during those critical moments of blast-off. The information they gather is transmitted to a computer system, either onboard or ground-based processed by the computer; the trajectory is calculated, and the final orbit predicted. This orbit must be compared with the desired one whose characteristics have previously been fed into the computer and decisions made as to the corrections which must be applied to the rocket engines if the performance is not satisfactory. In spite of the complexity of the calculations involved, the control signals must be returned to the rocket with a total time delay measured in fractions of a second, or a few seconds at most.

Why do we strive for real-time closed-loop systems? The end result must be that they are more economical, or that profits are greater. This is accomplished through (1) a reduction in human error in the input and output operations, (2) improvement in predictions, and (3) frequent readjustments of conditions to maintain optimum results from the process operations. It is apparent that whenever manual effort is removed from the input-output operations, reliability of the results is greatly improved.

ANALOG COMPUTERS

An analog computer essentially does not solve the specific problem we want solved, but it does solve an analogous one. When set up to solve a problem, there is a physical correspondence or similarity; mathematically, the computer is the analog of the system under study.

The electonic analog computer, usually called a differential analyzer, is the general-purpose computer of this type, and is the most common in use today. Like the general-purpose digital computer, it relies on vacuum tube and transistor circuits to achieve a very high speed of operation. Unlike its digital counterpart, however, the analog computer deals not with just two voltage levels, but with a whole continous range of values.

The analog computer circuits carry continuous timevarying voltages. These voltages, which are the actual solutions to the problem being solved, could be measured by voltmeters, but more frequently they are displayed and plotted against time by cathode ray oscilloscopes or automatic plotters. The values read or plotted are analog values.

In everyday life we read analog quantities. The speedometer reading of an automobile is an analog quantity, as is the reading of a bathroom scale. The accuracy of these measured quantities (including those of the analog computer) seldom exceeds three decimal digits, but in most cases this is sufficient.

Uses of the Analog Computer. - Analog computers as well as digital computers are used in the planning operations of an industrial system. They are used in the planning of new and special products, and in research. The products may be consumer or capital goods. An example of consumer goods is the automobile; the analog computer is very useful in the development of the spring system for the next year's automobile. The computer also plays a very important role in automation in the development of automatic machines that are capital goods used to perform the processing operations, such as automatic machine tools and automatic steel rolling mills. The automatic controls used in space vehicles and in the launching equipment are also developed with the aid of the analog computer.

One of the areas of research in which the analog computer has had important application is medical research. Here, for example, the computer is used to study the heart and blood circulatory system.

DIGITAL TECHNIQUES IN INDUSTRY

Digital techniques is a field already so vast and yet having such great potential that it is not possible to describe all the aspects of this branch of industrial electronics in this brief section. The advantages of digital techniques are so important that they are widely used in data processing, automatic machine control, process control, and telemetry. One of the major aspects of digital techniques is that of pulse control.

A pulse is a short, sharp change in voltage (or current). In this system, there is no such thing as small amplitude pulses or large amplitude pulses - the pulse is either there, or it isn't. Information is carried and control is accomplished by the number or arrangement of the pulses. Any conceivable type of information can be coded into some arrangement of pulses - the level of liquid in a tank, the position of a machine tool, the hours and rate of pay and deductions of workers, the speed of a conveyor belt, the activity of a nuclear reactor etc. And, because there is an unmistakable distinction between the presence and the absence of a pulse, almost any desired degree of accuracy may be obtained.

Another tremendous advantage of digital techniques is that only two different types of characters are needed, for example, a 0 to represent no pulse, a 1 to indicate presence of a pulse (binary number system). On the other hand, suppose you wanted to use the number 1,234,567,890 in a system using ordinary numerical methods. Ten different kinds of characters are needed. Using digital techniques, this number or any number may be represented by some pulse or no pulse arrangement.

ELECTRONICS FOR AUTOMATION

Electronics has many important uses in fields other than radio and television. Electronic devices are essential in almost every industrial process, and have made automation possible in many industries. Automation is the automatic control of a process or system for production. It makes possible a better and more uniform product at lower cost. This is accomplished by electronic devices that are able to substitute for human operators where they are not skilled enough, or are not fast enough, or under conditions where their presence would be too dangerous.

Electronics is also bringing automation to the office. It is being applied to filing, record keeping, record searching, payroll preparation, cost accounting, inventory control, and many other business management procedures. Automatic Data Processing (ADP) is the name given to this rapidly growing section of the automatic controls field.

Electronic devices are able to do these things because they can be made to sense, count, measure, sort, switch, and control with accuracy and speed far beyond the capability of human senses and reflexes.

PROGRAMMING

Programming a problem for solution on a digital computer is basically a process of translating from the language convenient to human beings to the language convenient to the computer. The language of the problem to be solved is mathematics or English statements of decisions to be made; the language of the computer is simple arithmetic and elementary choices, expressed in coded numerical form. By and large, we are at present required to present problems to the computer in its language.

QUESTIONS

1) Why is the information flow unique for each problem?
2) What are some physical forms of information?
3) Name four qualities of specific information.
4) Repeat the anthor's definition of "an item of information".
5) Give three examples for an item of information.
6) What does a transaction consist of?
7) Explain the term "identification data" by citing examples.
8) Depending on the needs of a system, what can "timeliness" refer to?
9) Which are the most important fields of application of digital techniques?
10) What is a pulse?
11) How can information be carried by means of pulses?
12) How can almost any desired degree of accuracy be obtained?
13) How many different types of characters are needed in digital techniques?
14) In what way can a very long number be represented when digital techniques are used?
15) Give a short summary of the advantages of digital techniques in industry.

IMPORTANT TERMS

analog(ue) computer	- Analogrechner m, Analogie-Rechengerät n, Analogierechenmaschine f
analog-to-digital encoder	- Analog-Digital-Wandler m
associative memory	- assoziativer Speicher
attribute	- Eigenschaft f, spezifisches Merkmal, Symbol n, Attribut n
automatic control	- automatische Steuerung, automatische Regelung
automatic machine	- Automat m
blast-off	- Raketenstart m
breakdown of cost(s)	- Kostenaufgliederung f
breakdown, to	- spezifizieren; (el) durchschlagen; (math) in Teile auflösen, zerlegen

business management procedures	- verwaltungstechnische Arbeiten f/pl (oder Vorgänge) m/pl
capital goods	- Produktionsmittel n/pl
cathode-ray oscilloscope	- Kathodenstrahloszilloskop n
closed-loop system	- Regelungssystem n mit geschlossenem Kreis
commodity	- Ware f, Gebrauchsgegenstand m, Gut n, Artikel m
computed	- berechnet
computer	- Rechner m, programmgesteuerter Rechenautomat
computer code	- Rechnerkode m
computer instruction	- Maschinenbefehl m
computer operation	- Rechnerprogrammablauf m
computing centre	- Rechenzentrale f, Rechenstelle f
computing inception	- Berechnung f des Eintretens
computing interval	- Rechenzeit f
computing machine	- Rechenmaschine f
computing time	- Rechenzeit f
content-addressed memory	- inhaltsadressierter Speicher, assoziativer Speicher
cost accounting	- Selbstkostenberechnung f
data processing	- Datenverarbeitung f
data processing equipment	- Datenverarbeitungsanlage f
data storage section	- Datenspeicher m
digital computer	- Digitalrechner m, Ziffernrechenmaschine f, numerische Rechenmaschine
electronic calculator	- elektronisches Rechengerät
electronic computer	- Elektronenrechner m, elektronische Rechenmaschine
electronic data processing	- elektronische Datenverarbeitung
electronic engineer	- HF-Ingenieur m
electronic parallel digital computer	- elektronischer parallel arbeitender Digitalrechner

electronic punch	elektronischer Locher
electronic punching machine	elektronisch lochendes Rechengerät
engineering specifications	technische Parameter m/pl
feed, to	(ein)speisen, eingeben, zuführen
file, to	(comput) speichern; (office work) ablegen, ordnen; (mech) feilen
file	(comput) Speicher m
filing	(comput) Speichern n; Aktenablage f, Registratur f, Archivierung f
filing system	Speichersystem n
general purpose computer	Allzweckrechner m
general purpose, stored-program electronic digital computer	elektronischer Mehrzweck-Digitalrechner mit Speicherprogrammierung
heavily	weitgehend, in grossem Masse
identification data	Erkennungsdaten n/pl, Identifizierungsdaten n/pl
information flow	Informationsstrom m
information retrieval	Informationserschliessung f
input-output control unit	Eingabe-Ausgabeeinheit f
inventory control	Inventur f, Lagerhaltungskontrolle f
item ('aitəm)	Posten m, Rechnungsposten m, Punkt m
item of information	kleinste sinnvolle Informationseinheit, Elementardatenmenge f
job	Aufgabe f, Funktion f, Arbeit f, Beschäftigung f
key individuals	leitende Persönlichkeiten f/pl, Persönlichkeiten f/pl in leitenden Funktionen
launching ('lɔːntʃiŋ; 'lɑːntʃiŋ)	Abschiessen n, Abschuss m, Start m
launching site	Abschussbasis f, Raketengelände n
link, to	verbinden, verketten

machine tool	Werkzeugmaschine f
memory	Speicher m, Speicherung f
memory unit	Speicher m
monitor, to	Überwachen, kontrollieren
multiprocessor	Datenverarbeitungssystem n zum gleichzeitigen Abarbeiten mehrerer Programme
off-line	indirekt, unabhängig
on-line	direkt, mitlaufend
on-line computer	Prozessrechner m, prozessgekoppelter Rechner
on-line operation	Betrieb m in Direktverbindung von Peripherie und Zentrale, prozessgekoppelter Betrieb, on-line Betrieb m
on-line (data) processing	direkte (mitlaufende) Datenverarbeitung
open-loop system	rückführungslose Steuerung
orbit	Umlaufbahn f; Schale f (eines Atoms)
particular application	spezifische Anwendung
pattern of processing	Ablauf m der Bearbeitung, Bearbeitungsvorgang m
payroll	Lohnliste f, Lohnstreifen m
plotter	(comput) Kurvenschreiber m, Zeichenautomat m
process, to	(comput) (Daten) verarbeiten
process control	Verfahrensregelung f; (comput) Fertigungssteuerung f
processing plant	Fertigungsanlage f, Bearbeitungsbetrieb m
programming	Datensteuerung f, Programmierung f, Programmgestaltung f
pulse control	Impulsregelung f, Impulssteuerung f
real-time computer	Echtzeitrechner m
real-time processing	Sofortverarbeitung f, Echtzeit(daten)-verarbeitung f
record	(comput) Datensatz m, Datenblock m; Aufzeichnung f; Schallplatte f

record keeping	- Archivierung f; Registerführung f, Registrierung f
record searching	- Informationsrecherche f, Registersuche f
retrieve, to	- wiedererlangen, wiedergewinnen
rolling mill	- Walzmaschine f, Walzwerk n, Hütte f
speedometer	- Geschwindigkeitsmesser m, Tachometer n, Kilometerzähler m
storage	- (comput) Speicherung f, Speicher m
storage device	- Speicher m
storage locations	- Speicherzellen f/pl, Speicherplätze m/pl
storage part	- Speicher m
store, to	- speichern
telemetry	- Fernmesstechnik f, Telemetrie f
time delay	- (comput) Laufzeit f; Zeitverzögerung f; Einschwingzeit f (eines Zeigers); Schaltverzug m; Anstiegszeit f
timeliness (of information)	- (comput) Aktualität f
tool	- Werkzeug n, Gerät n, Instrument n; Drehmeissel m
trajectory ('trædʒiktəri)	- Flugbahn f, Geschossbahn f; (math) Trajektorie f
transistorize, to	- mit Transistoren bestücken, transistorisieren
trigger off, to	- triggern, auslösen

GRAMMAR and NOTES

1. This classification is not necessarily an indication of their physical size (although large-scale computers do require more floor space), but rather is used as a general price-scale categorization.

Der intensive Aspekt (The Intensive, or Emphatic Aspect).
Mit Hilfe der Verbform kann der Sprechende nicht nur eine Unterscheidung nach einfachem und progressivem Aspekt vornehmen, sondern gleichzeitig

nachdrücklich einen Sachverhalt oder eine Meinung unterstreichen. Diese Art der besonderen Sicht oder "Beleuchtung" eines Vorganges heisst "intensiver Aspekt". Dass es sich hierbei um eine subjektive Stellungnahme und daher um einen Aspekt handelt, zeigt sich darin, dass der verbale Vorgang als solcher durch die eintretende Formveränderung in keiner Weise berührt wird.
Der intensive Aspekt tritt nicht selbständig auf, sondern verbindet sich entweder mit dem einfachen oder mit dem progressiven Aspekt.

Bezeichnet wird der intensive Aspekt durch ein betontes Hilfsverb:

a) im Präsens und Präteritum der einfachen Konjugation durch do/did; vor allem auch bei Verben, die in der Verlaufsform nicht üblich sind:
I do think (or: believe) you're right.
Ich glaube doch, du hast recht!
I do wish you had asked me.
Ich wünschte doch, du hättest mich gefragt!
It does make a difference.
Es ist schon ein Unterschied!
He did say so.
Er hat es ja (doch) gesagt.

Ebenso im Imperativ, auch bei be:
Do be careful!
Sei doch (oder: ja) vorsichtig!
Do stop talking!
Hör doch auf zu reden!

b) in allen übrigen Zeiten sowie im Konditional der einfachen Konjugation ähnlich wie im Deutschen durch starke Betonung des ersten Hilfsverbs (in gedruckten Texten oft durch Kursivschrift kenntlich gemacht):
I think you haven't told me about it. - But I have told you!
Du hast mir wohl nichts davon gesagt. - Ich habe es dir aber gesagt!

Das gleiche gilt für die Verlaufsform auf allen Zeitstufen:
Why aren't you doing your homework? - I am doing it!
Weshalb machst du denn nicht deine Hausaufgaben? - Ich mache sie ja!

Bei Verben, die im allgemeinen nicht im progressiven Aspekt erscheinen, kommt der intensive Aspekt auch in der gewöhnlichen (d.h. normalbetonten) Verlaufsform zum Ausdruck:
I'm loving this sort of music.
Diese (Art) Musik liebe ich geradezu!
I've been wanting to speak to you.
Ich habe schon immer mit ihnen sprechen wollen!

Eine sehr wichtige Funktion hat der intensive Aspekt heute bei Verben, die normalerweise als Zustandsbezeichnung nicht in der Verlaufsform gebraucht werden. Hier spielt der intensive Aspekt die Rolle einer "Brücke", die die Ueberleitung zum Gebrauch der Verlaufsform als progressiver Aspekt ermöglicht.

Beispiele für den gelegentlich gebrauchten intensiv-progressiven Aspekt sind etwa

1) bei Sinneswahrnehmungen:
I'm hearing it better now. Jetzt höre ich es (aber)schon besser!
I'm seeing it more clearly now. Jetzt sehe ich es schon deutlicher!

2) bei geistigen Fähigkeiten und Neigungen:
I'm forgetting everything today. Heute vergesse ich aber auch alles!
I'm hoping I shall be lucky. Ich hoffe doch, ich werde Glück haben!
I've been meaning to write to you. Ich habe Ihnen wirklich schreiben wollen!
I am thinking we may stay here a bit. Ich glaube doch, dass wir ein Weilchen hierbleiben (können).
I suppose you're wanting to drive the car in. Just a minute. Du möchtest wohl den Wagen hereinfahren? Einen Augenblick!
How I'm hating the sight of it all. Wie mir der Anblick von all dem verhasst ist!
Are you liking that new novel you're reading? Gefällt Ihnen denn der neue Roman, den Sie jetzt lesen?

Zu beachten (und zum Teil heute zu beobachten) ist hierbei, dass die zunächst nur gelegentlich im intensiven Aspekt gebrauchte Verlaufsform sich ausbreiten und zur normalen Form werden kann.

2. Anmerkungen

1) Beachten Sie die Vielfalt der Bedeutungsvarianten von "rather":

a) ziemlich, recht, fast, etwas

The test was rather a success. Der Test war ein ziemlicher Erfolg.

I would rather think you are wrong. Ich möchte fast glauben, dass Sie unrecht haben.

b) lieber, eher (als), anstatt, und nicht

I would much rather go to the lecture. Ich würde viel lieber zur Vorlesung gehen.

Treating the variables as discrete, rather than as continuous, is the more realistic approach.

Es ist realistischer, die Variablen als diskret und nicht als stetig zu betrachten.

c) vielmehr, eigentlich

He arrived late last night, or rather early this morning.

Er kam gestern spät abends an, oder eigentlich erst heute früh.

The contrary is rather to be supposed.

Vielmehr ist das Gegenteil anzunehmen. (Es ist eher das Gegenteil anzunehmen.)

2) the automatic equipment which physically wires the circuit - die automatische Vorrichtung, welche die Schaltung materiell aufbaut (ausführt)

3) a device called a plotter - ein Gerät, das "Zeichner" genannt wird (-ein Zeichenautomat, eine Zeichenmaschine)

4) data - Information(en). Zum Beispiel: This data is transmitted by a satellite.

5) input - Definition: "Information transferred from secondary or external storage into the internal storage of the computer".

6) ... not easy to come by - ... fällt einem nicht in den Schoss

7) that the detailed pattern...is unique for every problem - ...dass der Informationsfluss für jedes Problem im Detail anders abläuft.

8) ...for users to be involved in... - dass die Auftraggeber in... einbezogen werden. Beachten Sie folgende Uebersicht zu

"to involve":

"To involve" ist ein sogenanntes "vogue word", ein Modewort, dass sich im technischen Englisch sehr hartnäckig hält. Die Uebersetzung richtet sich nach dem Kontext. Einige Beispiele:

- erfordern, voraussetzen

This is a difficult course in that it involves a general knowledge of all branches of engineering. - Dies ist ein schwieriger Kursus, da er ein Allgemeinwissen in allen ingenieurtechnischen Disziplinen voraussetzt.

- betreffen

Experimental verification of the Einstein equation has been obtained by the study of processes involving nuclei of atoms. - Die experimentelle Bestätigung der Einstein-Gleichung ist durch die Erforschung der die Atomkerne betreffenden Prozesse erbracht worden.

- gelten

The principles involved in current flow through vacuum and gas tubes are also applicable to the phototubes. - Die für den Stromfluss durch Vakuum- und Gasentladungsröhren geltenden Prinzipien sind auch auf die Photozellen anwendbar.

- "involve" bleibt unübersetzt

To measure this current will involve the use of a voltmeter. - Zum Messen dieses Stromes wird ein Voltmeter benötigt.

- (als Eigenschaftswort) kompliziert

The field of dielectrics is an involved one, dealing with the behaviour of electrical nonconductors. - Das Gebiet der Dielektrika ist kompliziert, denn es befasst sich mit dem Verhalten elektrischer Nichtleiter.

9) it does have attributes - ...so hat sie doch spezifische Merkmale

10) messages or records - Nachrichten (Mitteilungen) oder Aufzeichnungen "Record" bedeutet im engeren Sinne "Datensatz" oder "Datenblock", d.h. eine Zusammenfassung einzelner Daten.

11) transaction - "aktuelle Eingabeinformation, die einen Datenverarbeitungsprozess aktiviert". (Für diesen Begriff gibt es keine eindeutige deutsche Bezeichnung.)

12) ...or the time that the information...was known to be correct - ... oder auf den Zeitabschnitt, während dem die Information im Datensatz als richtig bekannt war.

13) open-loop control - offene Steuerung (A control method in which signals are transmitted through the system without feedback.)

14) returns of political elections - (laufend eingehende) Ergebnisse politischer Wahlen

15) the data input operations are... - Die Dateneingabe besteht aus... ("operations" bleibt am besten unübersetzt)

16) "off-line" - Uebertragen von Informationen im off-line Betrieb (unabhängiges Arbeiten)

17) "on-line" - Uebertragen von Informationen im on-line Betrieb (Direktverbindung von Peripherie und Zentrale)

18) closed-loop control - Regelung (A control method using a feedback loop and, in consequence, working with the principal feedback at its minimum point)

19) ...in those process operations - in diesen Prozessen ("operations" bleibt unübersetzt)

20) decisions made as to... - decisions must be made as to...

21) Speicher = storage, storage device, storage part, storage unit, memory, memory unit

22) Prägen Sie sich die Wortgruppe "like" ein:

like (Adj., Adv., Präp.) - wie, gleich
like (Subst.) - der, die, das Gleiche
like (Verb) - lieben, mögen, gern haben, gefallen

likely (Adv., Adj.)	- wahrscheinlich, voraussichtlich
alike (Adj., Adv.)	- gleich, ähnlich, ebenso; in gleicher Weise
unlike (Adj., Präp.)	- ungleich, verschieden; nicht wie, anders als, im Gegensatz zu
23) there is no such thing as	- es gibt nichts dergleichen wie
24) some pulse or no pulse arrangement	- bestimmte Reihenfolge (Serie, Anordnung) von vorhandenen und fehlenden Impulsen
25) by and large	- synonyme Ausdrücke: on the whole; taking everything into consideration

EXERCISES

1. Insert the correct preposition:

1) The Universal Automatic Calculator (UNIVAC) may be considered the first step (from, into, toward) completely automatic data processing. 2) Previously, computers had been built only (in, for, to) scientific and engineering data processing purposes. 3) This computer is capable (in, with, of) storing twice as much data. 4) Numbers were represented internally in powers of two, or in what is referred (to, upon, by) as the binary numbering system. 5) A job that took 300 days to complete (from, through, by) hand could now be accomplished (on, in, with) a day. 6) (From, in, since) 1968 great success has been achieved (by, in, without) computer construction. 7) In recent years, the trend has been (during, up, to, toward) producing medium-scale systems. 8) Hundreds of new stations were put (in, into, to) operation.

2. Put in the correct forms of the verbs:

1) The storage device may be able... (durchsuchen) its own contents in order to... (finden) the desired information. 2) They have done all in their power ... (verringern) distortion at the source to a minimum. 3) Data is retrieved from the file by... (spezifizieren / festlegen) some of the characteristics of

the data itself. 4) If you require a computer... (machen, ausführen) a calculation or... (lösen) a problem, you have to feed it with the necessary information. 5) Optical memories show considerable promise for... (speichern) huge amounts of information in a very small volume. 6) There is a trend toward... (verwenden) the wide variety of input-output equipment already available. 7) Our students have already finished... (studieren) the initial data. 8) The multiprocessor approach achieves increased capacity by... (bereitstellen, liefern) many processors.

3. Form complete sentences

Example: A human operator transfers the data.
It is not necessary...

Solution: It is not necessary for a human operator to transfer the data.

(Translate these sentences into German.)

1) Each word is pulled out of storage. It is not necessary...
2) Each word is examined. It is not necessary...
3) They will use the new programming techniques. It is difficult...
4) They give considerable attention to the man-machine interface. It is time...
5) We utilize these new techniques. It is necessary...
6) This approach will provide a significant improvement in overall reliability.
7) We place more emphasis on the storage part of the computer. It is necessary...
8) The data storage section will become an active element. It is desirable...
9) This approach will improve speed. It is desirable...

4. Form nouns out of the following verbs:

to add / perform / apply / react / purify / consider / contain / know / express / discover / describe / demonstrate / develop / operate / measure / require / interpret / vary / begin / invent / solve / fail

5. Form verbs out of the following nouns:

display / weight / pressure / observation / multiplication / combination / replacement / storage / linkage / information / definition / difference / constitution

6. Form adjectives out of the following nouns:

responsibility / weightlessness / structure / impossibility / nature / nucleus / atom / molecule / importance / electricity / element / activity / presence / heat / effect

7. Translate into German:

1) Like the digital computer it relies on vacuum tube and transistor circuits to achieve a very high speed of operation. 2) Unlike vacuum tubes the transistor does not need to be heated to produce a flow of current. 3) Insulators are made of glass, rubber, mica, and the like. 4) I should like the question answered. 5) This investigation is likely to yield good results. 6) Complex molecules, like starch or rubber contain large numbers of carbon atoms. 7) Some substances are alike in their properties but differ in their mass.

8. Translate into English:

1) Bei der direkten Datenverarbeitung ist die Verzögerungszeit am kürzesten (Die kürzeste Verzögerungszeit...). 2) Unter diesen Bedingungen ist die Verzögerungszeit so kurz, dass sie vernachlässigt werden kann (vernachlässigbar ist). 3) Seit etwa 1945 arbeiten die Wissenschaftler nun an Elektronenrechnern. 4) Der logische Entwurf ist im wesentlichen der gleiche geblieben. 5) Das Rechenwerk ist ein aktiver Teil des Computers. 6) Mit diesem Computertyp ist es schwierig, nichtnumerische Daten zu verarbeiten. 7) Beträchtliche Forschung wird auf dieses Problem verwandt. 8) Die neuen Computer werden die gegenwärtigen nicht ersetzen. 9) Die neue Computerorganisation wird mehr Gewicht auf den Speicher legen. 10) Wir brauchen einen assoziativen Speichertyp. 11) So ist es möglich, dass der Speicher zu einem aktiven Element wird. 12) Adressierbare Register werden nicht notwendig sein. 13) Die Wörter werden in das erste verfügbare Register eingeordnet.

Lesson Thirty

AGRICULTURE and FORESTRY

(American)

Agricultural Engineering - a specialized branch of engineering - is concerned with the development, upkeep, and most efficient usages of agricultural machinery, farm structures, farm power, and soil and water control. It is a profession which, in the broadest sense, had its beginning with man's first need and his struggle for existence. The story begins with the cave, lean-to, or other crude shelter where early man housed his few domesticated animals, and it comes up to the modern mechanical milk production plants. The story also includes developments from the back-breaking toil of harvesting grain with the hand sickle and flail, to the self-propelled combine operating on the broad fields of the grain belt, which cuts, threshes, and bags wheat at the rate of some 50 acres a day. Nor should the story stop with present-day developments, for the most fascinating chapters lie ahead - chapters to be filled with advances from the team of scientists who are devoted to broadening and enriching agricultural technology. Soil physicists, agronomists, horticulturists, animal scientists, farmers, plant pathologists, agricultural engineers, and many others make up this team. In the solution of a given problem, it is very often necessary for the agricultural engineer to contribute as a member of the team. He must be able to understand and work with people as well as with scientific problems. In a problem of mechanizing the harvest of a given crop, the basic solution may not lie in the area of machine design or redesign, but in cooperation with the botanist or plant breeder in developing a new variety of plant that is better adapted to presently available machines. Once a solution is found, the team is dependent on the agricultural engineer, perhaps more than on any other member, to translate and carry the process or development into practical usage.

Professional Training. - As young people,both boys and girls, begin to evaluate their capabilities and interests with a view to selecting a life's work, it is perhaps sufficient for them to consider at first only the broad, overall engineering profession, which involves forces, materials, power applications, machine design and layouts, and the organization and management of human resources in relation to the above. Later, the selection of a particular branch of engineering may be considered. A liking for, and ability in, secondary school general science, chemistry, physics, and mathematics are excellent indicators for later success in engineering training. Such indicators may be far more valuable than an inclination to tinker with mechanical things,although this in itself may suggest a curious,inquiring mind, which is one requisite to the successful engineering career. Factors which might lead the prospective engineer to select agricultural engineering include a rural or small-town background, which may result in an appreciation of rural life, including both its compensations and problems; an interest in the growing of plants and animals; an interest in problems involving food, including the better feeding of the peoples of the world; the desire to be a part of an improved engineering service to the oldest and still most basic of our industries; and a desire to help solve the multitude of engineering problems associated with the industry. With reference to the latter factor, agriculture is a composite of some five million relatively small operations. Because the agricultural production unit is so closely interrelated with the home, an understanding of economic principles and their application is of particular importance for the agricultural engineer. From an engineering standpoint, he is confronted with definite challenges which include the weather, biological variables, and widely varying soils and soil conditions, and, most often, is faced with the need to solve engineering problems with a minimal capital outlay. These conditions point to the first basic requirement of the agricultural engineer - a thorough grounding in engineering fundamentals. In recognition of this requirement, many engineering colleges have developed a common program for all freshmen engineering students, with continuing similarity of studies during the second, and part of the third,years. Such a program appropriately provides for thorough grounding in mathematics, chemistry, physics, theoretical and applied mechanics, hydrology, hydraulics, electricity and magnetism, and other elements of the basic engineering curriculum.

There are approximately 45 professional agricultural engineering curriculums in the land grant colleges and universities of the United States, while several educational institutions in Canada offer a program leading to a professional degree. It is particularly during the past 20 years that engineering education has become dynamic, and that curriculum builders, including those in agricultural engineering, have made real efforts to keep abreast of recent technical developments. Accreditation standards, established by the Engineers Council for Professional Development (the recognized agency for the engineering profession), have been met by agricultural engineering curriculums at about 25 American colleges and universities. Many curriculums allow for some specialization, roughly corresponding to the areas of application in which agricultural engineers normally engage. These include farm power and machinery, farm structures, rural electrification, soil and water control, and, in some instances, agricultural processing. There is also an increasing appreciation of and demand for the agricultural engineer who is qualified to provide an integrated engineering service for a given agricultural operation which might include several or perhaps all of the above areas.

Fields of Specialization. - Farm power and machinery is the field in which the majority of agricultural engineers express a primary technical interest and find employment. Assignments in the field vary widely, but include design, research, and development of experimental and prototype machines, testing, and sales. They may be employed not only with the so-called full-line farm machinery companies, but with manufacturers of component parts. Producers of petroleum products, manufacturers of crop drying equipment, and a great number of other industries making products for the agricultural industry regularly employ agricultural engineers. Industrialists often consider them to be the best qualified individuals to translate the needs of the farm operator to the manufacturer in language understandable to the latter. American farmers have invested millions of dollars in farm machinery. Farms have become larger in size but fewer in number, while machines and mechanization are, in many instances, replacing the "hired man" of past literary fame. Farming, as a way of life, is giving way to farming as a business. Competition among manufacturers of farm equipment has become as keen as in any other major line of business. Farmers are also becoming increasingly conscious of equipment costs and operating cost differentials, the efficiencies of machines, comfort factors, and built-in safety features. Agricultural engineers who are employed by manufacturers of farm machinery and equipment are offered ample challenge in this field to stimulate the development of the highest professional standards.

In farm structures, the agricultural engineer may be concerned with the design and construction of buildings that can withstand the pressures of a wide variety of farm goods, as for example silage, wheat, or pelletized feeds. Others in the field may be engaged in the design, manufacture, marketing, and erection of buildings for drying grain and hay, for the conditioning of other feeds, and for the processing of agricultural products. Their primary technical interest may be the application of new building materials, and an improved application of old materials. The agricultural engineer is confronted with a major task in helping the farmer maintain, replace, and keep his buildings abreast of technological progress, for the farmer has more than one fifth of his total capital outlay invested in farm buildings.

In soil and water control, agricultural engineers are usually employed and are most active in upper waterway development, which includes gully control, small retention dams, retaining walls, lined and unlined ditches, terraces, and other engineering aspects of soil and water control practices. Irrigation, until recently thought of in terms of arid regions only, today is finding increased application in humid areas, particularly on high value per acre crops.

Agricultural drainage problems associated with highway and airfield developments are also of increasing concern to agricultural engineers. In the soil and water field, some of the problems facing them are the use of simple, yet reasonably accurate, means of determining when to irrigate; water-plant growth relationships; the use of plastics and other new materials in irrigation and drainage; the depth and spacing of drains; and the movement of soil moisture. Here, they are associated with civil engineers, soil physicists, agronomists, and other highly trained scientists. In this area, at least to as great an extent as in any other in the profession, the agricultural engineer most often works as a member of a team, and the results he discovers come from both teamwork and good team membership.

Teaching and Research. - Many agricultural engineers are employed by land-grant colleges and universities for teaching, research, and other public service responsibilities. The U.S. Department of Agriculture, and other major departments and divisions of the federal government, regularly employ agricultural engineers. In an increasing number of employment situations, the demand is for professional training that goes beyond the Bachelor of Science degree. Many leading colleges and universities now offer graduate programs leading to the Master of Science and the Doctor of Philosophy degrees.The success of agricultural engineers in private practice attests to the demand which exists for comprehensive engineering services, particularly for some of the larger farming operations.

FORESTRY

Forestry is the scientific management of forest lands for the continuous production of the many goods and services which man obtains from them. Forest lands produce wood and other products necessary to man; prevent soil erosion and regulate stream flow and water supply for irrigation, electric power, and domestic and industrial uses; constitute a home for wildlife; and serve as recreation areas for millions of persons. These benefits are everlasting on lands where the techniques of forestry are carefully and thoroughly applied. What is called sustained yield is then in effect, and the forest lands furnish a continuous supply of the products and services for which they are managed. Some United States forest lands, particularly those, such as the national forests, which are publicly owned, are managed under what is known as the multiple-use principle. Under scientific forestry practices they are made to yield as many different benefits as are consistent with the public interest. This does not mean, however, that the main emphasis is not placed on particular benefits, as, for example, watershed protection. On certain forest lands, such as those owned by the forest industries, timber production may be the major objective, but even on some of these lands owners consider values other than timber in making their forestry plans.

Forestry has developed in the United States only since the beginning of the 20th century, and the first American foresters were trained in Europe, where forestry had long been practiced. Nevertheless, American forestry differs in many ways from that of Europe. The use in the United States of different forms of forest management is necessary because of the highly developed and specialized methods and machinery of American lumbering, the enormous original timber supplies, the potential future supplies of timber, the size of the country, and transportation facilities that make most places far less dependent on local supplies of timber than is the case in Europe. The American forester also has to deal with different species, and in large measure he has been compelled to work out his own methods. Forestry in the United States has developed techniques applicable to various forest regions and types in the fields of protection from fire, insects, and diseases, artificial reforestation, timber growing, selective and rotation logging, wildlife management, recreation management, and watershed protection. In the western part of the country large areas of range land suitable for grazing are intermingled with forests and must be handled coordinately with them, a factor which has added range management to the field of American forestry.

Technical Forestry. - The science of forestry includes a number of specialized fields. *Silviculture* is the growing of timber as a crop, with the objectives of large yields of good quality, efficient harvesting, and quick and adequate reproduction after removal of the mature timber. *Forest protection* is the protection of forests against fire, insects, diseases, and other injurious and damaging agents. *Forest entomology* and *forest pathology* include the study and control of, respectively, insects and diseases affecting forest trees. *Forest utilization* is concerned with the efficient use of timber and other forest products. *Forest mensuration* determines the volume of material in timber stands and calculates yields. *Forest economics* includes the determination of values of growing stock in the forests, the compilation of forest statistics, and the study of economic factors in their relation to forestry. *Range management* is the protection, maintenance, and efficient utilization of forest and wild land areas suitable for grazing. *Forest wildlife management* is the maintenance and improvement of habitats for fish, game, and nongame species. The problems of planning, providing for, and regulating the recreational use of the forests constitute the specialized field of *forest recreation management*. *Forest engineering* includes surveying and mapping, road and trail construction, and the construction of airfields, buildings, signs, and other improvements necessary in managing forests.

QUESTIONS

1) Explain what is meant by: (a) agricultural engineering;
(b) forest engineering.

2) Why is an understanding of economic principles and their application of particular importance for agricultural engineers?

3) What is the difference between a farmer and a peasant?

4) Where is the grain stored?

5) What do we understand by professional agricultural engineering curriculums?

6) Name some fields of specialization of many curriculums.

7) What does the specialization "farm power and machinery" include?

8) Where are agricultural engineers employed?

9) What do we mean by "irrigation"? by "agricultural drainage"?

10) What natural advantages has American agriculture?

11) What is forestry?

12) What do forest lands produce?

13) What do we mean by "national forests"?

14) Why does American forestry differ in many ways from that of Europe?

15) Name some specialized fields of the technical forestry.

IMPORTANT TERMS

abreast (ə'brest)	- Seite an Seite, nebeneinander
to keep abreast (of,with)	- Schritt halten
accreditation	- Akkreditierung f, Beglaubigung f
accredited	- autorisiert, (offiziell) anerkannt, akkreditiert, beglaubigt
agricultural installation	- landwirtschaftlicher Betrieb
agricultural technology	- Ackerbautechnik f
agriculture	- Landwirtschaft f, Ackerbau m
agronomics	- Ackerbaukunde f
agronomist	- Agronom m

agronomy	- Agronomie f, Ackerbaukunde f
arid	- dürr, trocken, wasserlos
assigment	- Aufgabe f, Arbeit f; Anweisung f, Zuweisung f; Bestimmung f, Festsetzung f
background	- Hintergrund m; Lebenslauf m, Vergangenheit f (eines Menschen); Musik-, Geräuschkulisse f
botanist	- Botaniker m, Pflanzenkenner m
botany	- Botanik f, Pflanzenkunde f
built-in	- eingebaut
cave	- Höhle f
crop	- Ernte f
cultivation of the soil	- Bodennutzung f
curriculum (kə'rikjuləm)	- Lehrplan m, Studienplan m; Kursus m, Lehrgang m (a course of study in a school or university)
ditch	- Graben m, Kanal m, Rinne f
domestic animals	- Haustiere n/pl
draining of the soil	- Bodenentwässerung f
drying equipment	- Trockenanlage f
entomology	- Entomologie f, Insektenkunde f, Insektenlehre f
farm implements	- Ackergeräte n/pl
farm land	- Ackerland n
farmer	- Bauer m, Landwirt m
farmer line	- Farmerleitung f
farming	- Ackerbau m, Landwirtschaft f
feed, to	- füttern, ernähren
feed	- Futter n; Nahrung f
feeding	- Füttern n; Futter n; Nähren n, Ernähren n

fertile ('fəːtail)	- ergiebig, fruchtbar
fertility (fəː'tiliti)	- Fruchtbarkeit f, Ergiebigkeit f
fertilization (ˌfəːtilai'zeiʃ(ə)n)[-li'z-]	- Fruchtbarmachen n; (biol) Befruchtung f
fertilise, to	- fruchtbar machen; (biol) befruchten
fertiliser	- Befruchtungsstoff m; Düngemittel n
flail	- Dreschflegel m
forestation	- Aufforsten n, Beforsten n
forester	- Förster m
forestry	- Forstwirtschaft f
freshman	- Student m im ersten Semester; Neuling m, Anfänger m
game	- (zool) Wild n
game licence	- Jagdschein m
graduated engineer	- Diplomingenieur m
grain	- Getreide n, Korn n
grazing	- Weiden n, Weide f
gully ('gʌli)	- Abzugsgraben m, Kanalschacht m
habitat ('hæbitæt)	- (bot) Standort m; (zool) Lebensraum m
harvest, to	- ernten
harvest	- Ernte f
harvester	- Erntemaschine f, Mäher m Selbstbinder m
harvester and binding machine	- Bindemähmaschine f
harvester - binder	- Bindemäher m
harvester combine	- Mähdrescher m
harvesting machine for grass	- Graserntemaschine f
hay	- Heu n
hay maker	- Heuwender m; Heumacher m, Heuarbeiter m

horticulture	- Gartenbau m, Gartenbaukunst f
horticulturist (ˌhɔːtiˈkʌltʃərist)	- Garten(bau)künstler m, Gärtner m
hydrology (haiˈdrɔlədʒi)	- Gewässerkunde f, Wasserkunde f, Hydrologie f
irrigate, to	- bewässern, begiessen, berieseln
irrigation channel (or ditch)	- Bewässerungsgraben m
land drainage	- Bodenentwässerung f
land grant (U.S.)	- staatliche Landzuteilung (an Landwirtschaftsschulen etc.)
land-grant university	- durch staatliche (ursprünglich aus Land bestehende) Subventionen unterstützte Hochschule
lean-to	- Anbau m
lined	- (aus)gefüttert, ausgekleidet
logging (ˈlɔgiŋ)	- Holzfällung f, Holztransport m
lumber	- Bauholz n, Nutzholz n
lumber man	- Holzhauer m, Holzfäller m
mechanization (ˌmekənaiˈzeiʃən)[-niˈz-]	- Mechanisierung f
mensuration	- Abmessung f, Messung f, Vermessung f
outlay	- Ausgabe f, Auslage f, Betriebskosten pl
pathology	- Pathologie f, Krankheitslehre f Krankheitserscheinungen f/pl
pelletize, to	- pelletisieren
plough (plau)	- Pflug m
range	- (Am) ausgedehntes, unkultiviertes Weide -od. Jagdgebiet
retention dam	- Staudamm m
rural life	- Landleben n
shelter	- Zuflucht f, Obdach n, Schutz m (mil) Bunker m, Luftschutzraum m
sickle	- Sichel f

silage (ˈsailidʒ)	- Silage f, Silofutter n
silage cutter	- Futterschneidemaschine f
silage fodder	- Silofutter n, Gärfutter n
silviculture	- Waldbau m, Forstkultur f
soil	- Boden m, Erdboden m, Erde f, Land n
soil analysis	- Bodenanalyse f
soil conservation	- Melioration f
soil-draining plant	- Bodenentwässerungsanlage f
soil exhaustion	- Bodenerschöpfung f
soil improvement	- Bodenverbesserung f, Gütung f
soil science	- Bodenkunde f, Bodenlehre f
soil testing	- Bodenuntersuchung f
sustain, to	- unterhalten, aufrechterhalten ; aushalten, ertragen; stützen
timber	- Nutzholz n, Bauholz n
timber loader	- Holzausschlepper m
tinker, to	- herumflicken, herumpfuschen
toil	- mühselige Arbeit
topsoil	- Ackerkrume f, Bodenkrume f
topsoil plough	- Schälpflug m
upkeep	- Unterhalt m, Unterhaltung f, Wartung f, Instandhaltung f, Aufrechterhaltung f
watershed	- Wasserscheide f ; Einzugsgebiet n, Stromgebiet n; Ablauffläche f
wheat	- Weizen m
yield (jiːld)	- Ertrag m, Aubeute f; (agric) Ernte f

GRAMMAR and NOTES

1. Agricultural drainage problems associated with highway and airfield developments are also of increasing concern to agricultural engineers.

Hinweise zur Betonung

I. Eine Reihe von Wörtern griechischer, lateinischer oder französischer Herkunft sind – anders als ihre Äquivalente im Deutschen – im Englischen anfangsbetont:

access
accuracy
active
adequacy
adequate
amateur
ampere
armature
aspect
atom

battery
bulletin

cabinet
catalogue
colleague
complex
complicated
concept
contrast
cubic

decimal
delegate
digital
diode
dynamo

element
energy
evident
expert

figure
finite

fragile
frequency
function
fundament
fusion

gravity

hydrogen

import
industry
infinite
institute
instrument
integral
interval

licence
linear
logarithm

magnet
metal
method
microscope
mineral
minute
molecule

object
operator
oxygen

patent
patented

period
pilot
presence
primary
principle
process
product

radiator
rapid
region
regular
relative

second
secondary
sentence
special
subject
synchronous

tangent
telescope
tendency
theory
turbine

volume

aber:
machine
minute (mai'nju:t) = very small

II. Substantiv mit Anfangsbetonung, Verb endbetont

alloy	to alloy
contact	to contact
contrast	to contrast
decrease	to decrease
import	to import
increase	to increase
object	to object
progress	to progress
record	to record
reference	to refer to
survey	to survey
transfer	to transfer

aber:

concern	to concern
process	to process
purpose	to purpose

III. Suffixe, bei denen der dem Suffix vorausgehende Vokal betont wird:

-al	(bei Ableitungen von Substantiven auf -ment, -ent): elemental, experimental, fundamental, incidental, instrumental
-ial:	artificial, essential, industrial, special, substantial
-ian:	electrician, historian, mathematician, optician, physician, technician
-ic, -ics	(bei Substantiven): characteristic, dielectric, dynamics, economics, electronics, mathematics, nucleonics, physics, statistics
-ic, -ical	(bei Adjektiven): atomic, electronic, energetic, galvanic, magnetic, synthetic; chemical, economical, philosophical, practical, theoretical, typical
-ion:	composition, concentration, conduction, connection, criterion, explosion, extension, ignition, vibration
-ious, -eous:	homogeneous, instantaneous, simultaneous, spontaneous
-ible:	audible, indivisible, permissible, reversible, visible; aber: negligible (ˈneglidʒəbl)
-itive:	additive, definitive, positive, sensitive
-ity:	capacity, elasticity, electricity, rapidity, reliability, velocity
-graphy:	crystallography, lithography, metallography, photography
-grapher:	photographer, stenographer
-logy:	bacteriology, biology, meteorology, technology, terminology

-meter: ammeter, barometer, galvanometer, speedometer, voltameter;
aber anfangsbetont: centimetre (-eter).

-metry: barometry, geometry, photometry, trigonometry

-nomy: agronomy, astronomy, economy

-ual: continual, individual, mutual, residual

IV. Die Betonung liegt 2 Silben vor dem Suffix bei:

-fy: amplify, electrify, rectify, simplify, specify

-ise, -yse, -ize: analyse, electrolyse, industrialize, neutralize, signalize, specialize, stabilize

-ate: Verben [-eit]: estimate, indicate, insulate, investigate, separate
Substantive und Adjektive [-it]: adequate, estimate, separate, sublimate

In zweisilbigen Verben liegt der Hauptton gewöhnlich auf dem Suffix: equate, rotate

In zweisilbigen Substantiven und Adjektiven liegt der Hauptton auf dem Stamm, meist auf der ersten Silbe: chlorate, climate, filtrate, nitrate

2. Anmerkungen:

1) College (U.S.) -	a) College n, höhere Lehranstalt (selbständig od. vereinigt mit einer Universität, mit meist vierjährigem Lehrplan den Uebergang bildend zwischen der höheren Schule, high school, und dem Universitäts- od. Berufsstudium), b) Institut n (für Sonderausbildung).
(Br.)	a) College n (Wohngemeinschaft von Dozenten und Studenten innerhalb einer Universität) b) höhere, einen Bestandteil einer Universität bildende Lehranstalt: University College (in London) c) eine der grossen Public Schools wie Eton etc. d) Lehranstalt für besondere Studienzweige: Naval College - Marineakademie e) College(gebäude) n f) Kollegium n, Gemeinschaft f
2) Curriculum, pl - lums, - la -	a) Studienplan m, Lehrplan m, Lehrprogramm n, b) Kursus m, Lehrgang m. One: This school has only one curriculum which must be followed by all students. Several: The comprehensive high school has various curricula to meet differing needs.
3) Institute -	Institut n, Anstalt f, Akademie f, Einrichtung f; (ped.) a) höhere technische Schule, Hochschule* b) Universitätsinstitut, c) auch teacher's institut - Lehrerseminar n *Swiss Federal Institute of Technology-ETH

4) Some University Degrees (G.B.)

a) Degree of bachelor, obtained after three years of study (before taking this lowest degree the student is an undergraduate):

B.A. = Bachelor of Arts
B.S. or: B.Sc. = Bachelor of Science
LL.B. = Bachelor of Laws, etc.

b) Degree of master, obtained after further studies at the university (those studies are called post-graduate studies):

M.A. = Master of Arts
M.S. or: M.Sc. = Master of Science, etc.

c) Degree of doctor, highest university degree:

Ph.D. = Doctor of Philosophy
LL.D. = Doctor of Laws
M.D. = Doctor of Medicine
Litt.D. = Doctor of Literature; or: Doctor of Letters.

In America, the older British system has been overlaid by the German plan, so that both master of arts and doctor of philosophy are given. The college course of four years, prescribed to a greater or less extent according to the university or college at which it is given, leads up to a bachelor's degree, usually in arts, science or philosophy, according to the amount of attention devoted to the classics and natural sciences. The various technical and professional schools, which may or may not require a college degree or a certain amount of college work for admission, give a bachelor's degree, except in the case of medicine and dental medicine, where the first degree is usually that of doctor. The master's degree is given upon the completion with credit of a year or two of post-graduate work, with or without the writing of a thesis. The doctorate in philosophy and science, and occasionally in theology and law, is given much after the German fashion, upon from two to five years of post-graduate work, the writing of a thesis and the satisfactory passing of written and oral examinations.

The more familiar degrees are usually known by the following abbreviations:

C.E.	Civil Engineer
C.M. or Ch.M. (Chirurgiae Magister)	Master of Surgery
Ch.E.	Chemical Engineer
D.C.L.	Doctor of Civil Law
D.M.D. (Dentariae Medicinae Doctor)	Doctor of Dental Medicine
D.V.M.	Doctor of Veterinary Medicine
D.S., D.Sc., S.D., or Sc.D.	Doctor of Science
E.E.	Electrical Engineer
M.C.E.	Master of Civil Engineering
M.M.E.	Master of Mining Engineering
Ph.G.	Graduate in Pharmacy

EXERCISES

1. Complete the missing prepositions and form sentences:

a) abhängen von - to depend ...
sich beziehen auf - to refer ...
ersetzen durch - to replace ...
gelten für - to apply ...
bestehen aus - to consist ...
sich ergeben aus - to result ...
Erfolg haben bei, gelingen - to succeed ...
handeln von, sich beschäftigen mit - to deal ...
sich interessieren für - to be interested ...
beschränken auf - to limit ...
to confine ...
überführen in - to transfer ...
führen zu, bewirken - to result ...

beruhen auf - to rely ...
(sich verlassen auf)
trennen von - to separate ...
(heraus)nehmen aus - to take ...
suchen nach - to look ...
umwandeln in - to convert ...
sich unterscheiden von -
to differ ...
haften an - to adhere ...
achten auf - to pay attention ...
teilnehmen an - to take part ...

b) aus Mangel an - ... want of
aus diesem Grunde - ... this reason
bei dieser Gelegenheit - ... this occasion
beim Magnetisieren des Stabes - ... magnetising the rod
auf dieser Versamlung - ... this meeting
bis Sonntag - ... Sunday
bis auf 700 Grad - ... 700 degrees
aus Stahl gefertigt - made ... steel
Bedarf an Kupfer - want ... copper
auf diese Weise - ... this way
auf der Stelle - ... the spot

2. Translate into German:

most students/ the most important facts/ most books/ the most common computers in use today/ most of the book/ most complicated techniques/ the most complicated methods/ the most commonly used type

3. Translate into English:

1) Das Wesen der Landwirtschaft besteht in der planmässigen, regelmässig wiederholten Erzeugung von Planzen und Tieren. 2) Durch Bodenuntersuchung lässt sich feststellen, wieviel Nährstoffe ein Boden enthält. 3) Die feste Erdoberfläche setzt sich aus "Gesteinen" verschiedener Art zusammen. Die Wissenschaft, die sich damit befasst, ist die Geologie. 4) Die Verwendung landwirtschaftlicher Maschinen und Geräte hat immer mehr an Umfang zugenommen. 5) Alle Sorgfalt und Mühen bleiben

ohne Erfolg, wenn die für das Wachstum der Kulturpflanzen notwendige Feuchtigkeit fehlt. 6) Der Boden ist die wichtigste Produktionsgrundlage der Waldwirtschaft.

ANHAENGE - APPENDIXES

Anhang I

Schlüsselwörter - Keywords

abrasion test	Verschleissprüfung f
abrasive cutting	Trennschleifen n
automatic control technology	Regelungstechnik f
automatic lathe	Drehautomat m
automatic screw machine	Schraubenautomat m
automation	automatisierte Fertigung

bandsaw	Banksäge f
bar chucking	Stangenspannung f
bearing technology	Lagertechnik f
bevel gear generator	Kegelradwälzhobelmaschine f
bevel gears	Kegelzahnräder n/pl
boring	Aufbohren n, Innenausdrehen n
boring and milling machine	Waagerecht-Bohr-und Fräsmaschine f
boring machine	Bohrmaschine f
boring mill	Bohrwerk n
brazing	Hartlöten n
broach	Räumwerkzeug n
broaching	Räumen n
broaching machine	Räummaschine f

cam control	Kurvensteuerung f
cam form lathe	Nockenformdrehmaschine f
cam grinder	Nockenschleifmaschine f
camming	Kurvenbestückung f
carbide tipping	Hartmetallbestückung f
centerless grinding	spitzenloses Schleifen
chasing	Strehlen n
chemical milling	chemisches Fräsen
chucking	Futterbefestigung f
circular saw	Kreissäge f
climb milling	Gleichlauffräsen n
climb milling machine	Gleichlauffräsmaschine f
contouring	Umrisskopieren n
cooling	Kühlen n

copying	Nachformen n
copying lathe	Nachformdrehmaschine f
crank mechanism	Kurbeltrieb m
cutter grinder	Fräserschärfmaschine f
deep boring	Tiefbohren n
die-making	Gesenkherstellung f
die-sinking	Gesenkfräsen n
double-housing planer	Zweiständerhobelmaschine f
drilling	Vollbohren n
drill press	Ständerbohrmaschine f
drum miller	Trommelfräsmaschine f
dry grinding	Trockenschliff m
dust extraction	Staubabsaugung f
electroerosion	elektroerosive Bearbeitung
engine lathe	Leit- und Zugspindeldrehmaschine f
engraving	Gravierfräsen n
erection	Aufstellung f
external cylindrical grinder	Aussenrundschleifmaschine f
face grinding	Planschleifen n
facing lathe	Plandrehmaschine f
feed mechanism	Vorschubgetriebe n
fine-boring	Feinbohren n
fine-boring machine	Feinbohrmaschine f
form truing	Profilabrichten n
friction cutting	Reibsägen n
gaging	Lehrenkontrolle f
gang drill	Reihenbohrmaschine f
gear engineering	Verzahntechnik f
gear generator	Zahnradwälzhobelmaschine f
gear hobber	Zahnradwälzfräsmaschine f
gearing	Getriebetechnik f
gear lapping	Zahnradläppen n
gear shaping	Wälzstossen n
gear testing	Zahnradprüfung f
gear tooth element	Zahnrad-Bestimmungsgrösse f
generating	Wälzverzahnung f, Wälzfräsen n
generation grinding	Wälzschleifen n
generation shaping	Wälzstossen n
generator	Wälzhobler m, Stromerzeuger m
geometry of cutting	Schneidengeometrie f
grinder	Schleifmaschine f
grinding	Schleifen n

hacksaw	Bügelsäge f
heat treatment	Wärmebehandlung f
helical gears	Schrägzahnräder n/pl
hobber	Wälzfräsmaschine f
hobbing	Wälzfräsen n
honing	Ziehschleifen n
honing machine	Ziehschleifmaschine f
horizontal boring mill	Waagerechtbohrwerk n
hydraulic system	Hydraulik f

indexing	Teilen n
indexing table machine	Schalttellermaschine f
infeed grinding	Einstechschleifverfahren n

jig borer	Lehrenbohrmaschine f
jig boring	Lehrenbohren n
jig grinder	Lehrenschleifmaschine f
jig grinding	Lehrenschleifen n
jigmil	Waagerecht-Bohr- und Fräswerk n

keyseater	Keilnutenziehmaschine f
knee-type miller	Konsolfräsmaschine f

lapping	Läppen n
lapping machine	Läppmaschine f
laser	Laser-Strahltechnik f
lathe	Drehmaschine f
laying out	Anreissen n
liquid honing	Druckstrahlläppen n
magnetic crack detection	magnetische Rissprüfung
magnetic tape system	Magnetbandsteuerung f
material testing	Materialprüfung f
metal cleaning	Metallreinigung f
metal cutting	Zerspanung f
metal-cutting research	Zerspanungsforschung f
miller	Fräsmaschine f
milling	Fräsen n

multi-cut lathe	Vielschnittdrehmaschine f
multi-driller	Mehrspindelbohrmaschine f

openside planer	Einständerhobelmaschine f
operation	Arbeitsvorgang m
oxide ceramics	Oxydkeramik f

plain grinder	Rundschleifmaschine f
planer	Hobelmaschine f
planer-miller	Hobel- und Fräsmaschine f
planetary grinder	Innenschleifmaschine f mit Planetenspindel
polishing	Polieren n
precision borer	Feinstbohrmaschine f
product	Erzeugnis n
production	Fertigung f
profiler	Profilfräsmaschine f
programming	Programmsteuerung f
pump	Pumpe f
punched-tape control	Lochkartensteuerung f

radial	Auslegerbohrmaschine f
radioactive wear measurement	radioaktive Verschleissmessung
radiography	Röntgenographie f
recording	Aufzeichnung f
result	Arbeitsergebnis n
rotary miller	Karussellfräsmaschine f
roto-finishing	Trommelschleifverfahren n

sawing	Sägen n
sawing machine	Sägemaschine f
screwcutting	Gewindeschneiden n
serrations	Kerbverzahnung f
setting	Einstellen n
shaper	Waagerechtstossmaschine f
shaping	Waagerechtstossen n
single-point cutting tool	einschneidiges Werkzeug

slotter	Stossmaschine f
slotting	Stossen n
spark machining	funkenerosive Bearbeitung
speeds	Drehzahlen f/pl
spinning	Drücken n (Metall); Spinnen n
spiral grinding	Spiralschleifen n
splining	Keilverzahnung f, Keilnutenfräsen n
standard planer	Zweiständerhobelmaschine f
statics	Statik f
superfinishing	Feinstbearbeitung f
surface finish	Oberflächenbeschaffenheit f
surface metrology	Oberflächenmessung f
system of tolerances	Toleranzsystem n
tape recording	Lochstreifensteuerung f
taper attachment	Kegeldreheinrichtung f
taper turning	Kegeldrehen n
theory of fits	Passungslehre f
theory of grinding	Mechanismus m des Schleifens
thread grinding	Gewindeschleifen n
threading	Gewindeherstellung f
through-grinding	Durchlaufschleifen n
time study	Zeitstudienwesen n
tool element	Meissel-Bestimmungsstück n
tool grinder	Werkzeugschleifmaschine f
tooling	Meisseleinstellung f
tracer control	Fühlersteuerung f
transfer line	Transferstrasse f
traverse shaper	Stösselmaschine f mit Querschaltung des Stössels
truing	Abdrehen n
turret	Revolverkopf m
turret lathe	Revolverdrehmaschine f
ultrasonic drilling	Ultraschallbohren n
vertical turning and boring mill	Karusselldrehmaschine f
vertical turret lathe	Drehwerk n
vise (Am), vice (G.B.)	Schraubstock m

wear	Verschleiss m
wear measurement	Verschleissmessung f
welding	Schweisstechnik f
wet grinding	Nassschleifen n
wheel crushing	Rollprofilieren n
wheel dressing	Schleifscheibenabrichten n
work feeding	Werkstückbeschickung f
workholding	Werkstückspannung f
work study	Arbeitsstudium n
worm cutting	Schneckenradverzahnung f

Anhang 2

Wichtige englische und amerikanische Symbole und Abkürzungen

The Most Current English and American Symbols and Abbreviations

The following list contains a small selection of examples and should not be regarded as exhaustive.

Abbreviations for expressions such as those in this list are widely used in text to avoid the tedious repetition of the expressions in full. When an abbreviated term is first used in text, it is often advisable for clarity to give the name of the term first followed by its abbreviation in parentheses. As a general convention, lower-case letters followed by points are preferred for abbreviations. There are, however, some overriding circumstances in which capital letters should be used for a word or group of words, e.g. in headings or captions, or at the beginning of a sentence or when one or more of the words abbreviated is a proper noun. When for any reason the abbreviation for a group of words includes a capital letter, the initial letter of each abbreviated word should also be in capitals.

a	(UK) (acceleration), Beschleunigung f
a	gearing (US) (addendum), Zahnkopfhöhe f
a	metal-cutting (US) (back rake angle), Neigungswinkel m
a	gearing (US) (linear acceleration), geradlinige Beschleunigung f
a	gearing (UK) (pinion addendum), Zahnkopf m des Ritzels
A	ampere , Ampere n
A	gearing (US) (cone distance in bevel gears), Spitzenentfernung f
A	gearing (UK) (wheel addendum), Zahnkopf m des Zahnrades
A_o	metal-cutting (US) (cross-sectional area of cut), Spannungsquerschnitt m
abs.	absolute , absolut
a.c.	(UK) (alternating current), Wechselstrom m
A.C.	(alternating current), Wechselstrom m
Ah	ampere hour , Amperestunde f
A.I.E.E.	(American Institute of Electrical Engineers
amp.	(US) (Ampere), Ampere n

A.P.	(American Patent), amerikanisches Patent
ASA	(American Standards Association)
A.S.M.E.	(American Society of Mechanical Engineers
A.S.T.M.	(American Society for Testing Materials)
atm	(US) (atmosphere), physikalische Atmosphäre
avg	(US) (average), Durchschnitt m, Mittel n
A.W.G.	(American Wire Gage), amerikanische Drahtlehre
b, B	(breadth), Breite f
b	gearing (dedendum), Zahnfusshöhe f
b	gearing (UK) (pinion dedendum), Zahnfuss m, des Trieblings
B	gearing (US) (backlash), Flankenspiel n
B	drawing symbol (UK) (bore), aufbohren
B	(UK) (susceptance), Blindleitwert m
B	gearing (UK) (wheel dedendum), Zahnfuss m des Zahnrades
B.A.	threading (British Association /screw thread/), British Association Schraubengewinde n, Thury-Gewinde n
Bé	(US) (Baumé), Baumé
BF	drawing symbol (buff), schwabbeln
B.G.	(Standard Birmingham Sheet and Hoop Gauge), Birmingham Normallehre f für Feinblech und Bänder
Bhn	(Brinell hardness number), Brinell Härtezahl f
B.H.N.	(Brinell hardness number), Brinell Härtezahl f
b.p.	(UK) (boiling point), Siedepunkt m
Br.	Drawing symbol (brass), Messing n
BR	drawing symbol (broach), räumen
B.S.	(British Standard), britische Normvorschrift
B.S.F.	(British Standard Fine /thread/) britisches Norm-Feingewinde
B.S.T.	(British Standards Institution)
B.W.G.	(Birmingham Wire Gauge), Birmingham Drahtlehre f
c	gearing (UK) (bottom clearance), Grundspiel n (e. Kegelradpaares)
c	gearing (US) (clearence), Kopfspiel n

c	metal-cutting (US) (side cutting edge angle), Schneidenwinkel m
c	(US, UK) (specific heat), spezifische Wärme
C	(UK) (capacitance), kapazitiver Widerstand
C.	(UK) (centigrade), Grad Celsius
C	gearing (UK,US) (centre distance;cone distance), Achsabstand m; (von Kegelrädern:) Spitzenentfernung f
C	(US) (constant), Konstante f
C	(degree centigrade), Celsius
C	metal-cutting (machining constant),Schnittbearbeitungskonstante f
cbr.	(counterbored), zylindrisch versenkt
c. d.	(UK) (current density), Stromdichte f
C. D.	(cold drawn), kaltgezogen
c. g.	(UK) (centre of gravity), Schwerpunkt m
circ.	(circumference), Umfang m
C. I.	(cast iron), Guss m
C.L.A.	surface finish (centre-line-average), Rauhigkeitsmittel n in μ
const.	(US) (constant), Konstante f
cos	(US) (cosine), Kosinus m
C. P.	(circular pitch), Umfangsteilung f
cpd.	(UK) (compound), Gemenge n
C. R.	(cold rolles), kaltgewalzt
c/s	(cycle per second), Hertz, Periode f je Sekunde
C. S.	(cast steel), Gussstahl m
csk.	(countersunk), spitzversenkt
c.to.c.	(center to center), Mittenabstand m, Achsabstand m
cyl.	(cylinder, cylindrical), Zylinder m, zylindrisch
d	mech. (US) (density, weight per unit volume, mass per unit volume), Wichte f ;spezifisches Gewicht
d	(US)(depth),Tiefe f
d	metal-cutting (US) (depth of cut), Schnittiefe f
d,D	(diameter), Durchmesser m
d	gearing (UK), US) (pinion pitch diameter), Teilkreisdurchmesser m des Trieblings

d	mech. (UK) (relative density), relative Dichte
d	(US) (thickness), Dicke f, Stärke f
d_a	gearing (UK) (pinion outside diameter), Aussendurchmesser m des Trieblings
d_o	(US) (outside diameter of pinion), Aussendurchmesser m des Trieblings
d_θ	gearing (UK) (pinion base diameter), Grundkreisdurchmesser m des Trieblings
d_r	gearing (UK) (pinion root diameter), Fusskreisdurchmesser m des Trieblings
D	gearing (US) (pitch diameter of gear); (UK) (wheel pitch diameter), Teilkreisdurchmesser m eines Zahnrades
D_a	gearing (UK) (wheel outside diameter), Aussendurchmesser m des Zahnrades
D_a	gearing (US) (wheel tip diameter), Kopfkreisdurchmesser m des Zahnrades
D_G	gearing (US) (pitch diameter of gear), Teilkreisdurchmesser m des Zahnrades
D_i	gearing (US) (internal diameter), Innendurchmesser m
D_o	gearing (UK) (wheel base diameter), Grundkreisdurchmesser m des Zahnrades
D_o	gearing (US) (outside diameter of gear), Aussendurchmesser m des Zahnrades
D_p	(US) (pitch diameter of pinion), Teilkreisdurchmesser m des Ritzels
D_R	(US) (root diameter of gear), Zahnfussdurchmesser m
DB	drawing symbol (diamond bore), diamantbohren
d. c.	(UK) (direct current), Gleichstrom m
d-c	(US) (direct current), Gleichstrom ...
D. C.	(direct current), Gleichstrom m
deg	(US) (degree), Grad m
dil.	(UK) (dilute), verdünnt
D. P.	(diametral pitch), Durchmesserteilung f
Drg.	(drawing), Zeichnung f

e	(US) (efficiency), Leistung f
e_m	(US) (mechanical efficiency), mechanische Leistung
E	(US) (efficiency of machine tool, %), Wirkungsgrad m, (Leistung) der Werkzeugmaschine
E	(UK) (electric field strength), elektrische Feldstärke
E	(US) (electromotive force), elektromotorische Kraft
E	mech. (UK) (energy), Energie f
E	material testing (US) (modulus of elasticity), Elastizitätsmodul m, E-Modul m
E	gearing (US) (offset of axes in hypoid gears and face gears), Achsversetzung f in Hypoid- und Tellerradgetrieben
E	electr. (US) (voltage, elctric tension), elektrische Spannung
E	(UK) (Young's modulus), Elastizitätsmodul m
E.B.B.	(extra best best), Gütebezeichnung f für Drahtmaterial
eff	(US) (efficiency), Leistung f, Wirkungsgrad m
emf	(US) (electromotive force), elektromotorische Kraft
e.m.f.	(UK) (electromotive force), elektromotorische Kraft
engr	(US)(engineer), Ingenieur m
eq	(US) (equation), Gleichung f
equ.	(UK) (equation), Gleichung f
E.S.C.	(UK) (Engineering Standards Committee),Industrie-Normenausschuss m
f	(US) (coefficient of sliding friction),Reibungskoeffizient m
f	metal-cutting (US) (feed per revolution; feed per tooth), Vorschub m je Umdrehung ; Vorschub m je Schneidzahn
f	(US, UK) (frequency), Frequenz f
F	(US) (concentrated load, force), Kraft.f Gewicht n
F	(degree Fahrenheit), Grad m, Fahrenheit
F	gearing (US, UK) (facewidth), Zahnbreite f
F	(factor of safety), Sicherheitsfaktor m
F	drawing symbol (file), feilen
F	mech. (UK) (force), Kraft f

F	metal-cutting (friction force), Reibungskraft f
F	(US) (magnetomotive force), magnetomotorische Kraft
F	hobbing (number of flutes), Anzahl f Span-Nuten (im Wälzfräser)
F_c	metal-cutting (US) (cutting force), Schnittkraft f
F_s	metal-cutting (US) (shearing force). Scherkraft f
FC	drawing symbol (flamecut), brennschneiden
fl	(US) (fluid), flüssig
f.p.	(UK) (freezing point), Gefrierpunkt m
g	gearing (UK) (caliper thickness setting for pinion), Lehreneinstellung f für die Zahndickenmessung am Triebling
g	electr. (US, UK) (conductance), Leitwert m
g	gearing (UK) (constant chord thickness), konstante Zahndicke als Sehnenmass
g	(UK) (gravitational acceleration), Schwerkraftbeschleunigung f
G	gearing (UK) (caliper thickness setting for wheel), Lehreneinstellung f für die Zahndickenmessung am Zahnrad n
G	electr. (US, UK) (conductance), Leitwert m
G	drawing symbol (grind), schleifen
G	(UK) (shear modulus, rigidity), Schubmodul m
G.L.	(ground level), Flurebene f
G.M.	drawing symbol (gunmetal), Geschützbronze f
h	gearing (US) (depth, height), Tiefe f, Höhe f
h	gearing (UK) (constant chord height), konstante Zahnhöhe als Sehnenmass
h	(US) (head), Zughöhe f; Gefälle n
h	(US,UK) (height), Bauhöhe f; Höhe f
h	(relative humidity), relative Luftfeuchtigkeit
h_k	gearing (US) (working depth), Eingriffstiefe f
h_t	gearing (US) (whole depth), Tragtiefe f
H	metal-cutting (US) (Brinell hardness number), Brinell Härtezahl f
H	(head),Zughöhe f, Höhe f, Gefälle n
H	(height), Bauhöhe f, Höhe f

H	drawing symbol (hone), honen
H	(UK) (magnetic field strength), magnetische Feldstärke
hex.	(hexagon), Sechskant m
hp	(US) (horsepower), Pferdestärke f
h.p.	(UK) (horsepower), Pferdestärde f
h-p	(US) (high-pressure) Hochdruck~
H.P.	(horsepower), cf. h.p.
hr	(US) (hour), Stunde f
H.R.P. & L.	(hot rolled, pickled and limed), warmgewalzt, gebeizt und gekälkt
HSS	(high speed steel), Schnelldrehstahl m
H.T.S.	(high tensile steel), hochfester Stahl
I,i	(US) (current, current density), Stromdichte f
I	(UK) (electric current), elektrischer Strom
I	mech. (UK) (moment of inertia), Trägheitsmoment n
I	(US) (rectangular moment of inertia), axiales Trägheitsmoment
I.D.	(inside diameter), Innendurchmesser m
I.E.E.	(Institute of Electrical Engineers)
ISA	(International Federation of the National Standardizing Associations)
ISO	International Organization for Standardization)
IT	(ISA-tolerance), ISA-(Grund-) Toleranz f
J	electr. (UK) (current density), Stromdichte f
J	(US) (mechanical equivalent of heat), mechanisches Wärmeequivalent
J	(US) (polar moment of inertia), polares Trägheitsmoment
k	(US,UK) (radius of gyration), Krümmungsradius m (Euler)
k	(thermal conductivity), Wärmedurchgangszahl f
k_p	gearing (UK) (pinion addendum coefficient), Zahnkopf-Koeffizient m des Trieblings
k_w	gearing (UK) (wheel addendum coefficient), Zahnkopf-Koeffizient m des Zahnrades
K	(absolute temperature), absolute Temperatur
K	(constant), Konstante f
K	gearing (US) (factor), Faktor m (der Teilung)

K	(heat conductivity), Wärmeleitfähigkeit f
K	gearing (UK) (pitch factor), Teilungsfaktor m
K	mach. (rise or drop of cam), Kurvensteigung f
K	(specific resistance), spezifischer Widerstand
K_n	metal-cutting (US) (metal removal factor), spezifische Spanmenge
kip	(thousands of pounds), engl. Pfunde in tausend
kW	(US) (Kilowatt), Kilowatt n
kV	(kilovolt), Kilovolt n
I	(length), Länge f
I	gearing (US) (length of line of contact), Eingriffslinie f
L	electr. (US, UK) (inductance), Induktivität f
L	gearing (UK) (lead), Ganghöhe f
L_a	gearing (UK) (length of arc), Bogenlänge f (des Teilkreises)
L	electr. (US, UK) (self-inductance), Selbstinduktivität f
Ld	drawing symbol (lead), Blei n
L. H.	(left-hand), linksgängig
LP	drawing symbol (lap), läppen
m	mech. (US, UK) (mass), Masse f m = G/g
m	gearing (US, UK) (module; m = D/N), (britischer oder metrischer) Modul
m	metal-cutting (US) (weight of chip per unit length), Spangewicht n je Längeneinheit
m_p	gearing (US) (contact ratio of profiles), Profilüberdeckungsgrad m
m_t	gearing (US) (total contact ratio), Gesamtüberdeckungsgrad m
M	(UK) (bending moment), Biegemoment m
M	drawing symbol (mill), fräsen
M	(US) (moment of force), Moment n einer Kraft
M	(UK) (mutual inductance), Gegeninduktivität f
M/c	(machine), Maschine f
M.C.I.	(malleable cast iron), Temperguss m
M/cy	(machinery), Maschinenanlage f
m.m.f.	(magnetomotive force), magnetomotorische Kraft
mp	(melting point), Schmelzpunkt m
M.S.	(mild steel), niedriggekohlter Flussstahl
n	(US) (frequency), Frequenz f

n	gearing (UK) (pinion r.p.m.), Umdrehungszahl f des Trieblings
n	(UK) (revolutions per unit time), Drehzahl f
N	gearing (UK) (number of teeth), Zähnezahl f
N	gearing (UK) (wheel r.p.m.), Anzahl f gen des Zahnrades
N_G	gearing (US) (number of teeth in gear) Anzahl f Zähne im Zahnrad
N_p	gearing (US) (number of teeth in pinion), Anzahl f Zähne im Triebling
N_W	gearing (US) (number of threads in worm) Gangzahl f der Schnecke
NC	(National Coarse /thread/, Grobgewinde n
N.E.F.	(National Extra Fine /thread/, Extrafeingewinde n
NPS	(US)(National Pipe Straight), zylindrisches Rohrgewinde
NPT	(US) (National Pipe Taper /thread/, kegeliges Rohrgewinde
N.T.S.	drawing practice (not to scale), nicht massstabgerecht
O.D.	(outside diameter), Aussendurchmesser m
p	gearing (US,UK)(circular pitch), Teilung f (in den Stirnflächen als Bogenlänge)
p	mech. (UK) (momentum), Moment n
p	(US, UK) (pressure, absolute pressure), Druck, absoluter Druck
p	(US) (pressure per unit area), Druck m je Flächeneinheit
p	gearing (US) (radius of curvature), Krümmungshalbmesser m
p_n	gearing (US,UK) (normal pitch), Normalteilung f
p_t	gearing (US) (transverse pitch), Stirnteilung f
p_x	gearing (US) (axial pitch), Achsteilung f
P	gearing (UK) (diametral pitch), Durchmesserteilung f; s.a. P_d
P	(US , UK) (electric power), elektrische Leistung
P	(load), Gewicht n, Belastung f
P	drawing symbol (plane), hobeln
P	mech. (UK) (power), Leistung f

P	(US) (power, work per unit time), Leistung f, Arbeit f je Zeiteinheit (mkg/s)
P_a	gearing (UK) (axial pitch), Achsteilung f
P_d	gearing (US) (diametral pitch), Durchmesserteilung f
P_N	gearing (US) (normal base pitch), Normalgrundteilung f
P_n	gearing (UK) (normal diametral pitch), Normaldurchmesserteilung f
P.C.	(pitch circle), Teilkreis m
P.C.D.	(pitch circular diameter), Teilkreisdurchmesser m
p.d.	(UK) (potential difference), Spannungsunterschied m
P.D.	(pitch diameter), Teilkreisdurchmesser m
PO	drawing symbol (polish), polieren
p.p.m.	(UK) (parts per million), Millionstel n
psi	(pounds per square inch), (engl.) Pfund n Quadratzoll m
psig.	(pounds per square inch gage), Atmosphärenüberdruck m, atü
q	(US) (rate at which quantity of material passes through a machine), Durchgangsgeschwindigkeit f einer Werkstoffmenge durch eine Maschine
q	(US) (volume per unit time), Volumen n, je Zeiteinheit
Q	(US) (quantity by volume), Raummenge f
Q	(quantity, volume), Menge f, Volumen n
r	(US, UK) (radius), Halbmesser m, Radius m
r	metal-cutting (US) (side rake angle), Seitenwinkel m (γ_s)
R	gearing (UK) (gear ratio), Uebersetzungsverhältnis n des Zahnrades
R	drawing symbol (ream), reiben
R	electr. (US,UK) (resistance), Widerstand m
R_c	gearing (UK) (contact ratio), Eingriffsteilung f
R_g	gearing (UK) (gear ratio), Uebersetzungsverhältnis n des Zahnrades

rad	(UK) (radian), Radian, Radiant m
rad.	drawing symbol (radius), Halbmesser m, Radius m
Rc	(Rockwell C hardness), Rockwellhärte C
rd.	(round), rund
RG	drawing symbol (rough grind), grobschleifen
r.h.	(UK) (relative humidity), relative Luftfeuchtigkeit
R.H.	(right-hand), rechtsgängig
RM	drawing symbol (rough machine), schruppen
r.m.s.	(UK) (root mean square), quadratischer Mittelwert
rpm	(US) (revolutions per minute), Drehzahl f
rps	(US) (revolutions per second), Umdrehungen f/pl je Sekunde
rev/min	(UK) (revolutions per minute), Umdrehungen f/pl je Minute, Drehzahl f
s	mech. (US)(linear distance), Weg m
s	(US) (stress), Spannung f, Beanspruchung f
S	drawing symbol (scrape), schaben
S	metal-cutting (US) (tensile strength), Zerreissfestigkeit f
S_b	gearing (UK) (bending stress factor), Biegespannungsfaktor m
S_c	gearing (UK) (surface stress factor), Flächenspannungsfaktor m
S.A.E.	(Society of Automotive Engineers)
sec	(US) (secant), Sekante f
SP	drawing symbol (superfinish), feinstbearbeiten
sfpm	(surface feet per minute), Oberflächengeschwindigkeit f, in engl. Fuss je Minute
Sh.I.	(sheet iron), Stahlblech n
S.I.	threading (Système International), S.I. Gewinde n
sp.	(UK) (specific), spezifisch
sp.gr.	(UK) (specific gravity), Wichte f; spezifisches Gewicht
sq	(US) (square), vierkant, Quadrat ...
s.t.p.	(standard temperature and pressure), Normaltemperatur f und -druck m
S.W.G.	(Imperial Standard Wire Gauge), britische Normal-Drahtlehre

t	gearing (UK) (number of teeth in pinion, threads in worm), Anzahl f Zähne im Triebling, Gangzahl f der Schnecke
t	(US) (ordinary temperature), gewöhnliche Temperatur, Temperaturunterschied m
t	(US) (thickness), Dicke f, Stärke f
t	(US,UK) (time), Zeit f
t	gearing (US) (tooth thickness), Zahndicke f
t	metal-cutting (US) (true rake angle), Spannwinkel m (als Wirkwinkel)
t_b	gearing (US) (tooth thickness on base circle), Zahndicke f, am Grundkreis
t_c	gearing (US)(chordal thickness), Zahndicke f, als Sehnenmass
T	(US,UK) (absolute temperature), absolute Temperatur
T	metal-cutting (actual cutting time of tool between resharpenings), Standzeit f
T	(UK)(kinetic energy), kinetische Energie
T	gearing (UK) (number of teeth in wheel), Anzahl f, Zahnradzähne
T	(US) (period,cycle), Periodendauer f
T	drawing symbol (turn), drehen
T	(US,UK) (torque), Drehmoment n, Drehkraft f
t.p.i.	(threads per inch), Anzahl f je Zoll
T.P.I.	(threads per inch), Anzahl f Gewindegänge je Zoll
ts	(tensile streght), Zugfestigkeit f, Zerreissfestigkeit f
T.S.	(tensile strength), Zerreissfestigkeit f
u	(UK) (velocity), Geschwindigkeit f
U	metal-cutting (US) (rate of metal removal), Spannungsgeschwindigkeit f
U	gearing (UK) (time), Zeit f
U	gearing (UK) (time in hours), Zeit f in Stunden
ult.	(ultimate), äusserst; höchst
UNC	(Unified Coarse /thread/, vereinheitlichtes amerikanisches und britisches Grobgewinde, UNC-Gewinde n
UNF	(Unified Fine /thread/, vereinheitlichtes amerikanisches und britisches Feingewinde, UNF-Gewinde n

U.S.S.	(United States Standard), amerikanische Norm
v	kinem. (UK) (frequency), Frequenz f
v	(US) (linear velocity), lineare Geschwindigkeit
v	(US) (specific volume), spezifisches Volumen
v	(US) (Volt), Volt n
v_n	gearing (US) (velocity in normal direction), Geschwindigkeit f in Normalrichtung (in der Teilebene)
v_N	gearing (US) (velocity normal to surface), Geschwindigkeit f senkrecht zur Oberfläche
vt	gearing (US) (velocity in transverse direction tagential to pitch circle), Geschwindigkeit f in Querrichtung tangential zum Teilkreis
V	(US) (linear velocity), lineare Geschwindigkeit
V	metal-cutting (cutting speed), Schnittgeschwindigkeit f
V	(UK) (potential difference), Spannungsdifferenz f
V	(UK) (potential energy), potentielle Energie
V	(US) (total volume), gesamter Rauminhalt
V	(US) (velocity), Geschwindigkeit f
V	(US) (volt), Volt n
V	(US) (volume), Raum m, Volumen n
V_c	metal-cutting (US) (cutting velocity), Schnittgeschwindigkeit f
V_f	metal-cutting (US) (chip flow velocity),Spanauflaufgeschwindigkeit f
V_t	metal-cutting (US) (equivalent cutting speed), einer gegebenen Standzeit zugeordnete Schnittgeschwindigkeit
vac.	(UK) (vacuum), Vakuum n
vol.	(volume), Volumer n, Rauminhalt m
w	(US) (load per unit distance), Last f je Weglängeneinheit
w	(US) (weignt rate), Gewichtsverhältnis n
w	(US) (watt), Watt n
w	(US) (work per unit weight), Arbeit f je Gewichtseinheit
W	(UK) (electrical energy), elektrische Arbeit
W	electr. (US) (energy), elektrische Arbeit

W	mech. (UK) (energy), Energie f, Arbeit f
W	(US) (total load), Gesamtlast f
W	(US) (total weight), Gesamtgewicht n
W	(US) (volume), Rauminhalt m, Volumen n
W	(US) (watt), Watt n
W	(UK) (weight), Gewicht n
W	mech. (UK) (work), Arbeit f
W_n	metal-cutting (US) (specific power consumption), spezifischer Kraftbedarf
W.I.	(wrought iron), Schweissstahl m
W.M.	drawing symbol (white metal), Lagerweissmetall n
wt.	(US,UK) (weight), Gewicht n
X	(UK) (reactance), Blindwiderstand m
X	gearing (UK) (speed factor), Drehzahlfaktor m
X	gearing (US) (strength factor), Festigkeitsfaktor m
y	gearing (UK) (tooth form factor for circular pitch), Zahnformfaktor m der Stirnteilung
y	(UK) (admittance), Scheinleitwert m
Y	gearing (US) (tooth form factor for diametral pitch), Zahnformfaktor m der Durchmesserteilung
Y	metal-cutting (US) (yield stress of metal), Streckgrenze f des metallischen Werkstoffes
Z	(UK) (impedance), Scheinwiderstand m

Anhang 3

Hinweise zum Lesen mathematischer und physikalischer Zeichen

Indication od Reading Mathematical and Physical Expressions

Engl. Schreibweise:

1/2	a (one) half
1/3	a (one) third
1/4	a (one) quarter, a (one) fourth
1/5	a (one) fifth
6 3/5	six and three fifths
0.28	naught (nought) point (decimal) twenty-eight (or: two eight)
2.50	two point (decimal) five nought
10,000	ten thousand
10 . . . 20	ten to twenty
1 . . . 5	one to five
$a = b$	a equals b; a is equal to b
$a \neq b$	a is not equal to b
$a > b$	a is greater than b
$a < b$	a is less than b
$a \gg b$	a is much greater than b
$a \ll b$	a is much less than b
$a \geqslant b$	a is greater than or equal to b
$a \leqslant b; a \ngtr b$	a is less than or equal to b or: is not greater than
$a \nless b$	a is not less than b
$a \parallel b$	a is parallel to b
$a \nparallel b$	a is not parallel to b
$a \# b$	a is equal and parallel to b
$a \equiv b$	a is identical with b or: is always equal to
$a \perp b$	a is perpendicular to b
$A \veeeq B$	capital a (A) has the same angle as capital b (B)
$p:q :: s:t$	p is to q as s is to t
$5\ \mathrm{h} \mathrel{\hat{=}} 20\ \mathrm{km}$	five hours correspond to twenty kilometres
$a \approx b$	a is approximately equal to b
a_b	a sub b; a subscript b
b^a	a pre-sub b; a pre-subscript b
a^b	a super b; a superscript b
b_a	a pre-superscript b
$A_1 + A_2$	A one plus A two
$a + b$	a plus b
$a - b$	a minus b
$a \pm b$	a plus or minus b
$a \times b$	a times b; a multiplied by b
$a \div b$	a divided by b
$\frac{a}{b}$	a over b

$\frac{ab}{cd}$	a times b over c times d
$a'b''$	a dash times b double dash
$[a]$	a in brackets
$[a+b]\,c$	bracket [open] a plus b bracket [close] multiplied by c
(a)	a in parentheses
$a\,(b+c)$	a parenthesis [open] b plus c parenthesis [close]; a times the sum of b + c
$\{a\}$	a in braces
$\frac{1}{2}\left\{a\,[b+(c-d)]\right\}$	one half times brace [open] a bracket [open] b plus parenthesis [open] c minus d parenthesis bracket brace [close]
$\sin x$	sine x
$\cos x$	cosine x
$(\sin x)' = \cos x$	the (first) derivative of the sine of x equals the cosine of x
$\operatorname{tg} x$; $\tan x$	tangent x
$\operatorname{ctn} x$; $\operatorname{ctg} x$; $\cot x$	cotangent x
$\sec x$	secant x
$\operatorname{cosec} x$	cosecant x
$d\aleph$	infinity differential of x
$\frac{dy}{dx}$	dy by dx
$\frac{d^2y}{dx^2}$	d two y by dx squared
$f(x)$	function of x; f of x
$\delta f(x)$	delta times function of x
$\int$	integral
$\iint$	double integral
$\iiint$	triple integral
$\int f(x)\,dx = F(x) + C,$ if $F'(x) = f(x)$	the integral of small f of x dx equals capital F of x, plus capital C, if capital F prime of x is equal to small f of x
10^1	ten to the power of one; ten to the power one; ten to the first power; ten to the first
10^2	ten to the second; ten squared
10^3	ten to the third; ten cubed
10^{∞}	ten to the power [of] infinity
10^{-1}	ten to the minus first power
$10^{\frac{2}{3}}$	ten to the power of two thirds
a^n	a to the n^{th} [power]
a^{-n}	a to the minus n^{th} [power]
a^{-3x}	a to the power of minus 3x
$a^m \times a^n = a^{m+n}$	a to the m^{th} times a to the n^{th} is (equals) a to the power [of] m plus n
$a^m \div a^n = a^{m-n}$	a to the m^{th} divided by a to the n^{th} is (equals) a to the power [of] m minus n

$\left(\frac{x^2}{y^3}\right)^m$	x squared divided by y cubed in parentheses to the mth [power]
$\left(\frac{e^3}{E^4}\right)^r$	small e cubed divided by capital e to the fourth [power] in parentheses to the power [of] r
$\sqrt{a}$	square root of a
$\sqrt[3]{a}$	third (cube) root of a
$\sqrt[n]{a}$	nth root of a
$\sqrt{a+b}$	square root of the sum of a plus b
$\sqrt[n]{\frac{d}{g}} = t$	the nth root of d over g equals t
$\ln x$	natural logarithm of x
$y = \ln x$	y equals "l" "n" "x"
$\log x$	[common] logarithm of x
$\log_{10} 2 = 0.30103$	logarithm of two to the base ten is nought point three, nought, one, nought, three
$\lg 3.142 = 0.4972$	logarithm of three point one, four, two is nought point four, nine, seven, two
$\log_a (m\,n) = \log_a m + \log_a n$	logarithm of m times n in parentheses to the base a equals logarithm of m to the base a plus logarithm of n to the base a
$\log_a \frac{m}{n} = \log_a m - \log_a n$	logarithm of m over n to the base a equals logarithm of m to the base a minus logarithm of n to the base a
$\log_a \sqrt[r]{m} = \frac{1}{r} \log_a m$	logarithm of the rth root of m to the base a is one rth times logarithm of m to the base a
$\log \sin \beta$	logarithm of the sine of the angle β
[ ]	brackets
( )	parentheses (pəˈrenθisiːz)
{ }	braces

Siehe auch S. 29-30

Anhang 4

Amerikanisches Englisch - American English

Unterschiede - Persisting Differences

A) Derselbe deutsche Ausdruck wird anders ins amerikanische und anders ins britische Englisch übersetzt.

Einige Beispiele:

US-Englisch:	Britisches Englisch:
a (one) billion	milliard [a (one) thousand million(s)]
busy - "besetzt" Telephonleitung	engaged
can - Konserven-Dose (f), -Büchse (f)	tin
can opener - Büchsen-, Dosenöffner (m)	tin opener
check book - Scheckbuch (n), -heft (n)	cheque book
coal oil - Petroleum (n)	paraffin(e)
daylight - saving time - Sommerzeit (f)	summer time
Dead Letter Office - Abteilung (f) für unzustellbare Briefe	Returned Letter Office
deposit slip - Einzahlungsbeleg (m)	pay-in slip, credit slip
first floor - Erdgeschoss (n)	ground floor
forwarding note - Frachtbrief (m)	bill of consignment
gasoline (Kurzform: gas)- Benzin (n), Kraftstoff (m), (gasolene)	petrol
gear shift - Schalthebel (m), (Gang)Schaltung (f)	gear lever, gear shift lever
ground wire - Erdleitungskabel (n), Erleiter (m)	earth wire

Inc. (= incorporated) - als Aktiengesellschaft eingetragen	Ltd. (= limited)
letter carrier - Briefträger (m) mailman	postman
mail, to - (mit der Post) (ab)-schicken	to post
muffler - Schalldämpfer (m), Auspufftopf (m) (exhaust muffler)	silencer
railroad - Eisenbahn (f)	railway
recess - (Schul)Pause (f)	break
second floor - erster Stock (über dem Erdgeschoss)	first floor
spark plug - Zündkerze (f)	sparking plug
stairway - Treppe(n)(nhaus) (f), Stiege (f)	staircase (stairs)
steam shovel - Dampf(hoch)-löffelbagger (m)	steam - crave navy
stockholder- Aktionär (m), Aktienbesitzer (m)	shareholder
telegraph blank - Telegramm-formular (n)	telegraph form
ticket office - Fahrkarten-schalter (m)	booking office

B) Der gleiche Ausdruck, aber die Bedeutung ist verschieden:

		Britisches Englisch:	US-Englisch:
bureau	-	Schreibtisch (m)	Kommode (f)
corn	-	Getreide (n) Korn (n)	Mais (m), (auch in Australien)

creek -	kleine schmale Bucht, kleiner Hafen, enge Ebene zwischen Bergen	kleiner Fluss, Nebenfluss (m), zeitweilig trockener Wasserlauf (auch in Australien)
crevasse -	tiefer Spalt oder Riss, Gletscherspalte (f)	Bruch (m) im Deich oder Schutzdamm
davenport -	kleiner Sekretär (Schreibtisch)	Diwan (m) Chaiselongue (f) (Liegestuhl)(m)
schedule -	Liste (f), Tabelle(f) Verzeichnis (n)	(Lehr-, Arbeits-, Stunden-Plan (m), Fahrplan (m)

C) Das amerikanische Englisch unterscheidet sich von dem britischen Englisch ziemlich sehr in der Aussprache, z.B.:

schedule ('ʃedju:l) Br.
('skedʒul) US.

D) Die Satzmelodie des amerikanischen Englisch unterscheidet sich im wesentlichen dadurch, dass sie geringere TONHOEHENUNTERSCHIEDE und weniger Bewegtheit aufweist, so dass sie oft etwas einförmig klingt.

E) Im amerikanischen Englisch sind, insbesondere bei ENDUNGEN, einige Vereinfachungen durchgeführt worden, z.B.:

1) -or statt -our: color, honor, behavior (im britischen Englisch nur selten, z.B.: liquor, horror).

2) -er statt -re: theater, center, meter (brit.: metre = Meter , aber: barometer, gas meter etc.).

3) -se statt -ce: offense, defense.

4) Konsonantenvereinfachung: traveled; traveler; wagon; catalog (brit. catalogue); program (brit. programme); tarif (brit. tariff); check (brit. cheque); plow (brit. plough); tho (brit. though); thru (brit. through); auch im britischen Englisch schreiben wir:

diagram, telegram, gram(me).

F) Abweichende Regeln bei Silbentrennung

G) Andere Ausdrucksweise, z.B.:

Stick No Bills (brit.)

Post No Bills (US.) Plakatanschlagen verboten!

H) Grammatikalische Unterschiede, z.B.:

His brother is taller than him (Personalpronomen)

He has two sister-in-laws anstatt
He has two sisters-in-law (Plural der zusammengesetzten Wörter)

beatiful, beatifuller, beatifullest (Steigerung der drei- und mehrsilbigen Adjektive oft auf diese Weise).

Unter dem Einfluss des amerikanischen Englisch wird to have vor allem im Präteritum wie ein gewöhnliches Hauptverb in der Frage und in der Verneinung mit to do konstruiert:

He hasn't any money (brit.)

He doesn't have any money (US.) etc.

Amerikanische Umgangssprache (common speech) macht praktisch keine Unterschiede zwischen Adjektiven und Adverbien, z.B.:

Have you done it proper? (anstatt properly).

Sie verwendet auch zwei Verneinungswörter in einem Satz, z.B.:
We don't see nobody   anstatt: we see nobody.

In einer Reihe von Fällen unterscheidet sich der Gebrauch von Präpositionen (vor allem innerhalb der Umgangssprache) im amerikanischen Englisch von dem im britischen Englisch. Grundsätzlich ergeben sich dabei drei Möglichkeiten der Abweichung:

1. U. S. : keine Präposition - britisch: Präposition
Beispiel: a couple boys - a couple of boys

2. U. S. : andere Präpositionen als britisch
Beispiel: at a quarter of eight - at a quarter to eight

3. U. S. : Präposition - britisch: keine Präposition

I) lässige Umgangssprache (slang) wird oft verwendet.

J) Unterschiede in der Betonung, z.B. :
alloy - Legierung (f)   (ə'lɔi)   (brit.),   ('ælɔi)   (US.).

K) Unterschiede in der Interpunktion   (Zeichensetzung)

L) Unterschiede im Nebenakzent

Im amerikanischen Englisch ist, insbesondere in vier - und mehrsilbigen Wörtern, ein Nebenakzent (nach dem Hauptakzent) häufig auch dort bewahrt, wo im britischen Englisch Abschwächung oder Ausfall des Vokals eintrat. Dies gilt vor allem für die Endungen - ary, - ery, - ory. Beispiele:

'neces, sary (-e), 'mona, stery (-e-), pre'para, tory (-ɔ:-).

Definitions:

Standard English - the official language of Great Britain taught at schools and universities, used by the press, the radio and the television and spoken by educated people may be defined as that form of English which is current and literary, substantially uniform and recognized as acceptable wherever English is spoken or understood.
Local dialects are varieties of the English language peculiar to some districts and having no normalized literary form.
Variants are regional varieties possessing a literary form.

American English

The variety of English spoken in the USA has received the name of American English. The term variant or variety appears most appropriate for several reasons. American English cannot be called a dialect although it is a regional variety, because it has a literary normalized form called Standard American, whereas by definition given above a dialect has no literary form. Neither is it a separate language, as some American authors, like H. L. MENCKEN, claimed (H.L. Mencken, The American Language, New York, 1957), because it has neither grammar nor vocabulary of its own. From the lexical point of view we shall have to deal only with a heterogeneous set of Americanisms.

An Americanism may be defined as a word or a set expression peculiar to the English language as spoken in the USA.
Examples: cookie "a biscuit" ; frame house "a house consisting of a skeleton of timber, with boards or shingles laid on" ; guess "think" ; prairie "treeles plain, flat or rolling, naturally grass-covered " ; store "shop"; can "tin"; candy "sweets"; mailbox "pillar or letter box" ; suspenders "braces" ; truck "lorry" etc.
The American variant of the English language differs from British English in pronunciation.

The American English differs from British English in some minor features of grammar.

Another big group of peculiarities as compared with the English of Great Britain is caused by some specific features of stress or spelling standards , such as (æ) for a (a:) in ask, dance, path etc. or (e) for (ei) in made, day and some other.

The American spelling is in some repects simpler than its British counterpart, in other respects just different. The suffix - our is spelled - or, so that armor and humor are the American variants of armour and humour. Altho stands for although and thru for through.

Speaking about the historic causes of these deviations it is necessary to mention that American English is based on the language imported to the new continent at the time of the first settlements, that is on the English of the 17 th century. The first colonies were founded in 1607, so that the first colonizers were comtemporaries of Shakespeare, Spenser and Milton. For more than three centuries the American vocabulary developed more or less independently of the British stock and was influenced by the new surroundings. The early Americans had to coin words for the unfamiliar fauna and flora. Hence bull - frog "a large frog", moose (the American elk), opossum, raccoon (an American animal related to the bears), for animals, and corn, hickory, etc. for plants. They also had to find names for the new conditions of economic life, e. g. back - country "districts not yet thickly populated", back-settlement, backwoods "the forest beyond the cleared country", backwoodsman "a dweller in the backwoods" etc.

The opposition of any two lexical systems among the variants described is of great linguistic and heuristic (heuristic means "serving to discover") value because it furnishes ample data for observing the influence of extra-linguistic factors upon the vocabulary. American political vocabulary shows this point very definitely, e. g. : absentee voting "voting by mail", dark horse "a candidate nominated unexpectedly and not known to his voters", to gerrymander "to falsify", (satirical coinage preceding governor of Mass. when the method was employed in 1812), all-outer "an adept of decisive measures".

Many of the foreign elements borrowed into American English from the Indian dialects or from Spanish penetrated very soon not only into British English but also into several other languages, Russian not excluded, and so became international. They are: canoe, moccasin, squaw, tomahawk, wigwam, etc. and translation loans, e. g. : pipe of peace, pale-face and the like, taken from Indian languages. The borrowing was largely due to the popularity of J. F. Cooper and Henry Longfellow.

The Spanish borrowings like cafeteria, mustang, ranch, sombrero, etc. are very familiar to the speakers of many European languages. It is only by force of habit that linguists still include these words among the specific features of American English.

As to the toponyms, for instance, Jowa, Kansas, Michigan, Missouri, Utah (all names of Indian tribes), or other names of towns, rivers and states named by Indian words, it must be borne in mind that in all countries of the world towns, rivers and the like show in their names traces of the earlier inhabitants of the land in question.

In the course of time with the development of the modern means of communication, the lexical differences between the two variants show a tendency to decrease. Americanisms penetrate into Standard English and Britishisms (or Briticism) (a word, phrase or idiom peculiar to or characteristic of British English) come to be widely used in American speech. Americanisms mentioned as specific in manuals issued a few decades ago are now used on both sides of the Atlantic or substituted by terms formerly considered as specifically British . It was, for instance, customary to contrast the English word autumn with the American fall. In reality both words are used in both countries, only autumn is somewhat more elevated, while in England the word fall is now rare in literary use, though found in some dialects and surviving in set expressions, e. g. : spring and fall, the fall of the year are still in fairly common use.

The existing cases of difference between the two variants are conveniently classified into:

1) Cases where there are no equivalents in British English: drive-in "a cinema where you can see the film without getting out of your car", or "a shop where motorists buy things staying in the car"; dude ranch "a sham ranch used as a summer residence for holiday - makers from the cities". The noun dude was originally a contemptuous nickname given by the inhabitants of the Western states to those of the Eastern states. Now there is no contempt intended in the word dude. It simply means "a person who pays his way on a far ranch or camp".

2) Cases where different words are used for the same denotatum, such as can in the U.S.A and tin in England.

3) Cases where the semantic structure of a partially equivalent word is different. The word pavement, for example, means in the first place "covering of the street or the floor and the like made of asphalt, stones or some other material". The derived meaning is in England "the footway at the side of the road". The Americans use the noun sidewalk for this, while pavement with them means "the roadway".

4) Cases where otherwise equivalent words are different in distribution. The verb ride in Standard English is mostly combined with such nouns as a horse, a bicycle, more seldom they say to ride on a bus. In American English combinations like a ride on the train, to ride in a boat are quite usual.

5) It sometimes happens that the same word is used in American English with some difference in emotional and stylistic colouring. Nasty, for example, is a much milder expression of disapproval in England than in the States, where it was even considered obscene in the 19th century.

6) Last but not least, there may be a marked difference in frequency characteristics. Thus, time-table which occurs in American English very rarely, yielded its place to schedule.

This question of different frequency distribution is also of paramount importance if we wish to investigate the morphological peculiarities of the American variant.

Practically speaking the same patterns and means of word-formation are used in coining neologisms in both variants. Only the frequency observed in both cases may be different. Some of the suffixes more frequently used in American English are: - ee (draftee "a joung man about to be enlisted") - ette (tambour - majorette "one of the girl drummers in front of a procession"), - dom and - ster, as in roadster "motor-car for long journeys by road" or gangsterdom.

American slang uses alongside the traditional ones also a few specific models, such as verb stem + -er + adverb stem + -er, e.g. opener - upper " the first item on the programme" and winder - upper "the last item", respectively. It also possesses some specific affixes and semi - affixes not used in literary colloquial: -o, -eroo, -aroo, as in coppo "policeman", fatso "a fat man", bossaroo "boss". Slang words are identified and distinguished by contrasting them to standard literary vocabulary.

The trend to shorten words and to use initial abbreviations is even more pronounced than in the British variant. New coinages are incessantly introduced in advertisements, in the press, in everyday conversation, soon they fade out and are replaced by the newest creations.

Particularly common in American English are verbs with the hanging postpositive. They say that in Hollywood you never meet a man: you meet up with him, you do not study a subject but study up on it. In British English similar constructions serve to add a new meaning.

With words possessing several structural variants it may happen that some are more frequent in one country and the others in another. Thus, amid and toward, for example, are more often used in the States and amidst and towards in Great Britain. The lexical peculiarities of American English are an easy target for ironical outbursts on the part of British writers. A well - known humourist G. Mikes goes as far as to say: "It was decided almost two hundred years ago that English should be the language spoken in the United States. It is not known, however, why this decision has not been carried out".

It is a fact that there is a difference between the two variants to be reckoned with. Although not sufficiently great to warrant American English the status of an independent language, it is considerable enough to make a mixture of variants sound unnatural, so that students of English should be warned against this danger.

Anhang 5

Buchstabiertafel in Telefonbüchern

Spelling Table in Directories

British	American	German
A Andrew	A Abel	A Anton Ä Ägid
B Benjamin	B Baker	B Berta
C Charlie	C Charlie	C Cäsar
D David	D Dog	D Dora
E Edward	E Easy	E Emil
F Frederick	F Fox	F Friedrich
G George	G George	G Gustav
H Harry	H How	H Heinrich
I Isaac	I Ikon	I Ida
J Jack	Juliett	J Julius
K King	K King	K Kaufmann
L Lucy	L Love	L Ludwig
M Mary	M Mike	M Martha
N Nellie	N Nan	N Nordpol
O Oliver	O Obo	O Otto
		Ö Ökonom
P Peter	P Peter	P Paula
Q Queenie	Q Queen	Q Quelle
R Robert	R Roger	R Richard
S Sugar	S Sugar	S Samuel
T Tommy	T Tare	T Theodor
U Uncle	U Uncle	U Ulrich
		Ü Übermut
V Victor	V Victor	V Viktor
W William	W William	W Wilhelm
X Xmas	X (eks)	X Xanthippe
Y Yellow	Y Yoke	Y Ypsilon
Z Zebra	Z Zebra	Z Zeppelin
		(Zacharias)

SILBENTRENNUNG

Word Division

I. Trennung nach SPRACHSILBEN:

1/Zusammensetzungen werden nach ihren
Bestandteilen abgetrennt:
to-day, Sun-day, there-fore, faith-ful; in-to, up-on, an-other

2/nach deutlichen ABLEITUNGEN:
a/ Mit Vorsilben: Trans-form, re-mark, en-title
b/ Mit Endungen: busi-ness, favour-able, appar-ently, achieve-ment

3/nach silbischen Flexionsendungen: giv-ing, caus-ing, hop-ing, assist-ing, call-ing, tak-ing; wish-es, teach-es; add-ed, repeat-ed; match-es, box-es, fast-er, larg-est

4/Verdoppelte Konsonanten, die zur Erhaltung kurzer /geschlossener / Silben dienen, werden stets getrennt: get-ting, step-ping, cut-ting, knit-ted, nod-ded; hot-ter, big-ger

5/Wörter auf -ce, -ge, -se, bei denen die Endung vor -s /Mehrzahl/ silbisch wird, werden nach Sprechsilben abgetrennt: hou-ses, chan-ges, fa-ces

6/Einsilbig ausgesprochene Wörter dürfen nicht getrennt werden:
goes, takes; played, moved, showed; wife, wives, guessed

II. Trennung nach SPRECHSILBEN:

1/ Ein einfacher Konsonant gehört zur folgenden Silbe, auch wenn er durch zwei Buchstaben dargestellt wird (ch, gu/g/,sc, sh,ph,th/:
mu-sic, pro-perty, mo-ral; telegra-phy, de-scend, fa-ther, ri-ches;
Bei Ableitungssilben auch häufig: physi-cal, termi-nal

2/ Von mehreren Konsonanten gehört der LETZTE zur FOLGENDEN Silbe: cor-rect, con-nect, in-terest, or-gan, ad-dition, recog-nize, sud-den, pig-ment
Auch häufig bei Ableitungssilben: direc-tion, instruc-tion /immer -tion /; expres-sion, boun-dary, adven-ture, habi-tual, indispen-sable, moun-tain, succes-sive

3/ Aufeinanderfolgende Vokale können getrennt werden: po-em, di-et; auch: geo-logical, vio-lence

4/ -CK- und -X- bleiben bei der ersten Silbe /Ausnahme/: ex-act, pack-et, ex-aggerate

5/ -QU- gehört zur folgenden Silbe /Ausnahme/: fre-quent, fre-quency, conse-quent

6/ Durch l oder r wird ein vorangehender Konsonant gewöhnlich zur folgenden Silbe gezogen /Ausnahme/: con-trol, en-trance; accom-plish, accessi-ble.

Einige weitere Beispiele der Silbentrennung:

classifi-cation, ampli-fier, mon-ey, re-gret, ev-ery, doz-en, prof-it, aber: ex-amine, ex-ist;
chil-dren, coun-try, mer-chant, nar-row, let-ter, pas-senger, wea-ther, pock-et, se-cret, de-gree, volt-age, fif-teen, al-ways, ad-dress, be-cause, an-tenna, re-ceiver, modula-tion, pres-ent, run-ning, travel-ling, induct-ance, en-trance, trans-mission, resid-ual, differ-ence, coup-ling, superhet-erodyne, car-rier, mag-netic, differ-ence, op-erated, elec-trical, accord-ingly.

Anhang 7

Zeichensetzung und Gross-Schreibung

Punctuation and Capitals

1. Der Punkt (The Period) steht

a) am Ende eines vollständigen Satzes.

b) oft nach Abkürzungen (siehe die Bemerkung S. 26). Die einzelnen Buchstaben von Abkürzungen zusammengesetzter Namen internationaler Organisationen etc. werden heutzutage in der Hauptsache ohne Punkt und Abstand geschrieben, z.B.: UNESCO.

c) nach Dezimalstellen

z.B.: 18·50 ft. (Br.)
18.50 ft. (USA); das amerikanische lässt den Punkt auf der Zeile, wogegen das britische Englisch den Punkt zentriert.

d) oft nach römischen Zahlen, die zur Bezeichnung von Seiten oder Kapiteln dienen; in diesem Falle können diese Zahlen mit oder ohne Punkt verwandt werden. Falls sie hinter Eigennamen stehen, wird der Punkt nicht gesetzt, z.B.: James I .

e) nach Auslassungen oder Unterbrechungen; dies wird in einem Satze gewöhnlich durch drei Punkte angezeigt.

2. Das Komma (The Comma)

a) Wörter, Wortgruppen und Sätze werden in einer Aufzählung durch Kommas voneinander getrennt. Falls die Aufzählung mehr als zwei Glieder enthält, steht das Komma auch, wenn das letzte Glied durch eine Konjunktion (and oder or) angeschlossen ist, z.B.:

All the costs fell on John, Paul, and Peter.

Bisweilen lässt man das Komma vor and oder or aus.

b) Falls sich etc., or the like, and so on bei einer Aufzählung in der Endstellung befinden, ohne damit gleichzeitig den Satz zu beenden, folgt ihnen ein Komma.

c) Treffen zwei gleiche Wörter, Wendungen oder Zahlengruppen in einem Satze zusammen, so trennt sie ein Komma, z.B.:

He who asks, asks not in vain.

In the year 1972, 382 people frequented this place.

d) Einen Gegensatz ausdrückende Wörter oder Wendungen werden gleichfalls durch Kommas abgetrennt, z.B.:

Bread, not words, is what we are hoping for.

e) Das Komma deutet die Auslassung eines Wortes oder mehrer Wörter an, das zwei Satzteilen gemeinsam ist, aber nicht wiederholt wird, z.B.:

Frank failed in English; George, in mathematics.

f) Beziehen sich Adverbien auf einen ganzen Satz, so werden sie durch Kommas abgetrennt, z.B.:

Unfortunately, he was not able to come.

g) Längeren Adverbialbestimmungen, die nicht an gewohnter Stelle stehen, folgt meistens ein Komma, z.B.:

What he was thinking about his friend's behaviour, no one will ever know.

h) Falls Wörter wie

however, moreover, therefore, nevertheless, of course, too, then, indeed, accordingly, no doubt, consequently etc.

in einem Satz eingefügt sind, ohne dessen Sinn zu verändern, so dass sie auch weggelassen werden könnten, trennt man sie durch Kommas ab, z.B.:

Later, however, she decided to come.

Won't you come, too?

Anmerkung: Bei sehr kurzen Sätzen, in denen die Wörter ohnehin nahe dem Verb stehen, ist die Abtrennung nicht nötig, z.B.:

Consequently he decided to return.

Wenn einige der in dieser Regel genannten Wörter, z.B.:

too, indeed, however,

nicht weggelassen werden können, ohne den Sinn zu verändern, steht kein Komma. Z.B.:

The water was too cold.

i) Nach Ausdrücken wie

that is, i.e., as, namely, etc., e.g.,

die nicht eine Aufzählung einführen, sondern eine Erläuterung, steht ein Komma, z.B.:

There were only three persons present at the meeting: namely, Mr. Watson, Mr. Grant, and Mr. Kingstone.

Anmerkung: Vor sowie nach dem Ausdruck "such as" steht kein Komma.

j) Ein Komma steht nach

Anreden, Eigennamen, akademischen oder Ehrentiteln, z.B.:

Dear James,

Sincerely yours,

k) Nachgestellte Vornamen in Bibliographien etc. trennt das Komma ab, z.B.:

Smith, Edward C. John

l) Das Komma trennt den Monat vom Jahr und untergliedert grössere Zahlen von rechts in Dreiergruppen. Im britischen Englisch trennt es auch die einzelnen Glieder einer vollen Adresse, z.B.:

Mr. William Forster,
22, Palace Terrace,

London, W.C.1

The total number of the inhabitants of the town is 2,126,673 oder: 2 126 673 (ohne Komma als Uebergangsstufe).

Nach Einführung des metrischen Systems in Gross-Britannien:

2'126'673.

February 28, 1972

21st July, 1973

July 21st, 1974

Sunday, April 27, 1972 oder

Sunday April 27 1972 (in Zeitungen)

Abgekürzt kann man auch schreiben: 27-4-72,

27/4/72,

27.4.72

$19\,\frac{27.}{4.}\,72$

Fehlt bei einem Datum die Tagesbezeichnung, schwankt der Gebrauch zwischen Schreibung mit oder ohne Komma, z.B.:

May,1972; May 1972.

m) Appositionell, parenthetisch oder auch unabhängig gebrauchte Wörter, Wendungen und Satzglieder werden durch Kommas abgetrennt, z.B.:

His brother, a native of France, had preferred Switzerland to his country.

Fiddlesticks, I don't want that.

The notes were taken by Mr. Turner, Clerk to the Council.

Anmerkung: Im Gegensatz zum Amerikanischen fehlt im britischen Gebrauch der Punkt vielfach hinter

Mr, Mrs und Dr .

Besteht jedoch eine enge Gedankenverbindung zwischen dem Substantiv und seiner Apposition, so wird kein Komma gesetzt, z.B.:

William the Conqueror;

the architect William Fairways.

n) Hauptsätze, die durch eine nebenordnende Konjunktion verbunden sind, werden durch Kommas getrennt, z.B.:

She came early, as she had been asked.

Das Komma entfällt jedoch bei sehr kurzen Sätzen und besonders dann, wenn beide Sätze das gleiche Subjekt haben, z.B.:

He worked hard but he failed.

o) Als allgemeine Regel gilt, dass ein Komma nach einem Satz gesetzt wird, der nicht an gewohnter Stelle steht, z.B.:

What had happened during those days, she could not remember.

p) Durch Komma getrennt werden Adverbialsätze immer, wenn sie dem Hauptsatz vorangehen, und für gewöhnlich, wenn sie an einer anderen Stelle im Satze stehen, z.B.:

Try and meet me at seven o'clock, when you can make it.

If it is possible, you may be sure that the work will be done.

Anmerkung: Das Komma kann entfallen, wenn der Adverbialsatz kurz ist und Haupt- und Nebensatz das gleiche Subjekt haben, z.B.:

But if you want to win a prize you must before all things strive to win it.

Das Komma entfällt auch, wenn es sich um einen kurzen nachgestellten Adverbialsatz handelt oder überhaupt um einen, der keinen Bruch im Verlauf des Satzes verursacht, z.B.:

I will leave when he turns up.

She is a great deal cleverer than you are.

Ist die Anfügung jedoch unwesentlich, d.h. schliesst sie noch eine zusätzliche Begründung oder Einräumung mit

because, since, as, though

an, muss das Komma stehen, z.B.:

He has bought a new car, though I doubt if he can afford it.

q) Während ein Subjekt für gewöhnlich nicht von seinem Verb getrennt wird, ist ein Komma zwischen Subjektsatz und Hauptsatz zulässig, z.B.:

That the man was an ignoramus of the worst sort in this particular field of learning, is something which admits of no dispute.

r) Nicht notwendige Attributsätze, Relativsätze oder Partizipialsätze werden durch Kommas abgetrennt, z.B.:

Mary, feeling ill, went home soon afterwards.

I had a look at the stadium outside the town, which was only opened last summer.

Anmerkung: Ein notwendiger Relativsatz dagegen darf nicht durch Kommas abgetrennt werden, z.B.:

The man who won the swimming championship was given a medal.

s) Objekt- oder notwendige Attributsätze werden in einer Aufzählung durch Kommas voneinander, aber nicht vom Hauptsatz getrennt, z.B.:

She told me that she had lived in England these five months, that she had come to Germany to pass her examination, and that she wanted to return as soon as possible.

It is a house which had been built in 1942, which was damaged during the war, and which was rebuilt eleven years ago.

t) Ein Komma trennt absolute Partizipial- und Infinitivkonstruktionen ab, z.B.:

The visitors having left, normal life returned to the house.

They were all, to tell you what has happened, taken in by his words.

u) Bei der direkten Rede sowie bei kurzen Zitaten, Fragen und Maximen werden einleitende, eingeschobene oder nachgestellte

he said, she replied usw.

durch Kommas abgetrennt, z.B.:

She asked him hurriedly, "What measure do you propose?"

Besteht jedoch zwischen den einleitenden und den zitierten Worten kein syntaktischer Bruch, so braucht kein Komma zu stehen.

v) Die Frage am Ende der Aussage (Feststellung) wird durch Komma abgetrennt, z.B: You are coming too, aren't you?

w) Ein Komma trennt beigeordnete Adjektive, die dasselbe Hauptwort näher bestimmen, z.B: It was a quaint, old-fashioned, vine-covered cottage.

x) Durch Kommas getrennt werden absolute Konstruktionen sowie Nebensätze, die in die Mitte des Satzgefüges kommen, z.B. : The pears, although they had been freshly picked, became spoiled in shipment.

Anmerkung:
Im maschinegeschriebenen Manuskript folgt nach dem Komma ein Zwischenraum.

y) Ein Komma steht vor Konjunktionen and, but, for, or, yet und vor nor, wenn sie die Satzteile eines zusammengesetzten Satzes verbinden.

3. Das Ausrufezeichen (The Exclamation Mark)

steht

a) nach Ausrufen, ganz gleich, ob diese aus Einzelwörtern, Wendungen oder vollständigen Sätzen bestehen, z.B.:

I can never understand why he did this!

b) In einer Serie von Ausrufen steht hinter jedem einzelnen Ausruf ein Ausrufezeichen, z.B.:

I fall upon the thorns of life! I bleed! (Shelley)

c) Ein Ausrufezeichen wird auch gesetzt nach Wendungen oder Sätzen, die einem Wunsch, einem Befehl oder der Ironie und anderen starken Aeusserungen Ausdruck verleihen, z.B.:

"Stop this nonsense!" he shouted at the crowd.

So this is what you want me to believe!

What an idea!

4. Die übrigen Satzzeichen werden praktisch wie im Deutschen gebraucht.

Gross-Schreibung

Use of Capital Letters

Es wird angewandt bei:

a) dem ersten Wort eines vollständigen oder unvollständigen Satzes, dem ersten Wort eines Zitates oder einer Verszeile.

b) Eigennamen und Wörtern, die als solche gebraucht werden sowie bei deren Ableitungen im ursprünglichen Sinne, z.B.:

Roman Empire (aber: roman types).

c) Namen von Völkern, Rassen, Stämmen und Sprachen und bei von ihnen abgeleiteten Adjektiven, z.B.:

English; Romanesque; Apache tribe (Angehörige eines amer. Indianerstammes)

d) Ehrentiteln, akademischen und kirchlichen Titeln sowie bei Berufs- und Geschäftstiteln, die mit Eigennamen zusammen gebraucht werden, z.B.:

Queen Elizabeth; Dean Fisher.

Doctor of Laws (Doktor der Rechte)
Doctor of Medicine (Doktor der Medizin).

e) offiziellen und Regierungstiteln sowie Adelstiteln, z.B.:

Speaker of the House of Commons (Vorsitzender oder Sprecher des Unterhauses in G.B.)

President; Chancellor; Mr. Speaker! (Herr Vorsitzender!).

f) den amtlichen Bezeichnungen nationaler sowie internationaler Institutionen oder bei Dokumenten, z.B.:

The United Nations; Charter of the United Nations;
Congress (gesetzgebende Versammlung).

g) Substantiven und oft auch Adjektiven, die auf eine Gottheit Bezug nehmen sowie bei Pronomen und pronominalen Adjektiven, wenn Sie nicht dicht vor oder hinter dem Beziehungswort stehen, z.B.:

God; the Almighty (der Allmächtige);
Providence (die Vorsehung, Gott);
Holy Ghost (Heiliger Geist).

h) Namen von heiligen Schriften, ihren Teilen und Ausgaben sowie bei adjektivischen Ableitungen, die sich ausdrücklich auf diese Schriften beziehen, z.B.:

Bible; Old Testament; Koran; Biblic(al); Biblico-.

i) Namen von Glaubensbekenntnissen, kirchlichen Bezeichnungen und Mönchsorden sowie dem Wort Church, wenn es auf ein bestimmtes Kirchengebäude gemünzt ist, z.B.:

Church of St. David's; Buddhist;
Apostles' Creed (das Apostolische Glaubensbekenntnis).

j) Feiertagen, Monaten und Wochentagen, z.B.:

Christmas (Weihnachten); Easter (Ostern);
Whitsuntide (Pfingsten); Ascension Day (Christi Himmelfahrt, Himmelfahrtstag);
March; in March (im März); Friday; on Friday (am Freitag);
on Fridays (freitags).

k) Namen von Ausstellungen, Kongressen und Versammlungen, z.B.:

Brussels' World Fair (Messe, Ausstellung);
The Yalta Conference (1945).

l) Namen von historischen Epochen und literarischen Perioden, Namen von Gesetzen, Verträgen, Gerichtshöfen usw., z.B.:

Magna Charta (der grosse Freibrief (Grundgesetz) der engl. Verfassung, 1215);

Middle Ages (nur im Pl.!);

Napoleonic Wars; Victorian Age of Literature;

London Court of Appeals (Appellationsgericht);

Supreme Court of the United States (Oberbundesgericht der Vereinigten Staaten).

m) Namen von geologischen Perioden, Epochen, Formationen etc. sowie bei Namen prähistorischer Zeitalter, z.B.:

Bronze Age; Age of Coal; Cambrian (kambrische Formation).

n) Namen der Gattungen, aber nicht der Arten bei zweigliedrigen wissenschaftlichen Namen in der Zoologie und Botanik, z.B.:

Primula acaulis (stengellos).

o) neuen lateinischen Klassen- und Familienbezeichnungen sowie bei Namen von allen Gruppen, die umfassender sind als die Gattungen in der Zoologie und Botanik; ausgenommen hiervon sind abgeleitete Adjektive und Substantive.

p) Namen von Planeten, Sternbildern, Asteroiden usw., aber nicht bei Erde, Mond und Sonne, es sei denn, sie stehen mit anderen astronomischen Bezeichnungen zusammen oder im übertragenen Sinne, z.B.:

Jupiter; Mars; Uranus;

Sun of Righteousness (Sonne der Gerechtigkeit [Christus]),

aber:

empire on which the sun never sets (Reich, in dem die Sonne nie untergeht).

q) geographischen Gattungsnamen, die ein integrierter Bestandteil eines bestimmten Eigennamens sind:

country, district, continent, bay, colony, borough, ocean, river, sea, island, lake, mountain, hemisphere, pass, peninsula; und in der gleichen Weise:

road, street, avenue, boulevard, square, park, bridge, z.B.:

The Southern Hemisphere; Black Sea; Beach House Road; Rocky Mountains (Gebirge im Westen der USA), aber

Bavarian mountains.

r) politischen Gattungsnamen, die ein integrierter Bestandteil eines bestimmten Eigennamens sind und ein politisches Einteilungsprinzip andeuten:

republic, state, dominion, territory, empire, colony, kingdom, department usw., z.B.:

The Third Republic; the Holy Roman Empire; United Kingdom (Vereinigtes Königreich-Grossbritannien und Nordirland).

s) Namen bestimmter geographischer Gliederungen, z.B.:

The Middle East; the Orient.

t) Himmelsrichtungen, welche - geographisch gesehen - einen Teil eines Landes oder der Welt bezeichnen sowie bei deren adjektivischen und substantivischen Abteilungen, z.B.:

The Southeast (Südosten);

a Southerner (Bewohner des Südens (eines Landes) oder Südstaatler (in den USA)).

u) personifizierten abstrakten Ideen oder toten Gegenständen und bei personifizierten Jahreszeiten, z.B.:

Peace and Love.

v) allen Wörtern in den Titeln von Büchern, Zeitschriften, Essays, Gedichten mit Ausnahme der Präpositionen, Konjunktionen und Artikel; ferner bei akademischen Graden bzw. ihren Abkürzungen, z.B.:

An Experimental Course in the Fundamental Principles of Radio;

Doctor of Philosophy (Ph. D.).

In Verzeichnissen, Katalogen und Bibliographien werden in veröffentlichten Titeln bisweilen nur das erste Wort und die Eigennamen gross geschrieben. In Werbeschriften, Prospekten und dgl. werden ganze Titel oft gross geschrieben, also auch Präpositionen, Konjunktionen und Artikel (graphische Darstellung).

w) dem Artikel the, wenn er zu einem Eigennamen oder Titel gehört oder wenn er Teil eines gesetzlich geschützten Namens ist. Die Gross-Schreibung wird nicht angewandt, wenn im laufenden Text auf Tageszeitungen und Zeitschriften Bezug genommen wird, z.B.:

The Saturday Evening Post, aber:

... was to be found in the Saturday Evening Post.

x) Zusätzen zu amerikanischen Namen; bei anderen ausländischen Namen jedoch nur, wenn keine Vornamen, Berufsbezeichnungen, Adels- oder Höflichkeitstitel vorangehen, z.B.:

Van Dyck, aber: Anthonis van Dyck; Lee De Forest.

y) nicht anglisierten deutschen Wörtern in englischen Texten, z.B.:

Luftwaffe; Junker; Frau.

z) Namen, die ein gesetzlich geschütztes Warenzeichen sind.

Anmerkung:

Mit grossen Anfangsbuchstaben werden auch geschrieben:

1. das Personalpronomen I (der Deutlichkeit wegen).
2. die Interjektion O (Oh!)
3. an Stelle eines Doppelpunktes das erste Wort in den Anführungszeichen, z.B. : He asked, "Are you going too?"
4. das erste Wort einer direkten Frage innerhalb des Satzes, z.B.: This story answers the question, Where does true happiness really lie?

Anhang 8

Phonetische Umschrift

Guide to Pronunciation

Die phonetische Umschrift wird hier nach den Grundsätzen der "International Phonetic Association" (IPA) gegeben.

A. Vokale und Diphthonge

Die Länge wird durch das Zeichen (:) angegeben, die Kürze wird nicht bezeichnet.

Lautsymbol	Engl. Beispielwort	Lautcharakteristik
(i:)	see (si:)	Langes i, wie in "Biene", jedoch dumpfer, näher dem (e) liegend.
(i)	it (it)	Kurzes, offenes i, wie in "mit".
(e)	get (get)	Kurzes e, wie in "Bett".
(ɛ)	fair (fɛr)	Offener, zwischen (e) und (æ) liegender Laut wie ä in "lästig". (ɛ) kommt nur vor r vor, das im amerikanischen Englisch gesprochen, im britischen Englisch durch (ə) ersetzt wird. Im letzteren Falle entsteht der Diphthong (ɛə).
(æ)	cat (kæt)	Dieser Laut ähnelt der Interjektion "äh!"
(æ[:])	half Am. (hæ[:] f)	Kurzes oder langes (æ) im amerikanischen Englisch.
(a:)	father ('fa:ðər) (Am.) ('fa:ðə) (GB)	Langes, "dunkles", ein wenig nach (ɔ) klingendes a.
(a)	hot = (ɔ) im brit. Englisch (hɔt)	Sehr offenes, kurzes o, dem (a) nahestehend.

	= (a) im am. Englisch (hat)	Kurzes a. Die "Entrundung" von (ɔ) führt zu (a).
(ɔ)	hot (hɔt)	Sehr offenes, kurzes o, dem (a) nahestehend. Vgl. (a).
(ɔ:)	saw (sɔ:)	Langes (ɔ), aber nicht so offen wie bei (ɔ) und Lippen stärker gerundet.
(o)	molest (mo'lest)	Kurzes, geschlossenes o wie in "Protest".
(u)	put (put)	Kurzes u wie in "Kutsche".
(u:)	too (tu:)	Langes u wie in "Kuh".
(ʌ)	up (ʌp)	Dieser Laut existiert im Deutschen nicht. Lippen ein wenig auseinandergezogen, Mund ziemlich weit geöffnet.
(ə:)	bird (bə:rd) (Am.) (bə:d) (GB)	Aehnlich dem e im "Gabe", aber lang. Lippen auseinandergezogen, Mund wenig geöffnet. Vgl. auch (r).
(ə)	china ('tʃainə)	Etwa gleich dem e in "bitte". Findet sich im Englischen u. Deutschen nur in unbetonten Silben.
(ei)	day (dei)	Diphthong bestehend aus (e) u. folgendem (i).
(ou)	go (gou)	Diphthong bestehend aus (o) u. folgendem (u).
(ai)	fly (flai)	Dipthong bestehend aus "hellem" (a), wie in "Mann", und folgendem (i); die Zunge erreicht jedoch die (i)-Stellung meist nicht ganz, sondern nur (e).
(au)	how (hau)	Dipthong bestehend aus "hellem" (a), wie in "Mann", und folgendem (u); die Zunge erreicht jedoch die (u)-Stellung meist nicht ganz, sondern nur (o).
(ɔi)	boy (bɔi)	Diphthong bestehend aus (ɔ:), jedoch ohne Länge und folgendem (i).

B. Konsonanten

Die Konsonanten (b,p,d,t,g,k,f,h,m und n) werden im grossen ganzen wie im Deutschen ausgesprochen.

(b,d,g) werden voll stimmhaft,
(p,t,k) deutlich stimmlos – mit nachfolgendem Hauch-ausgesprochen.

(l)		Mit (l) werden zwei Arten von l-Lauten im Englischen wiedergegeben.
	1. leg (leg)	Helles l vor Vokalen. Mit Hebung der Vorderzunge.
	2. table ('teibl)	Dunkles (u-haltiges) l vor Konsonanten und im absoluten Auslaut. Mit Hebung der Hinterzunge.
(r)	bright (brait)	Weder ein deutsches Zäpfchen -r noch ein gerolltes Zungenspitzen -r. Die Zungenspitze bildet mit dem oberen Zahnwulst eine lose Enge, durch die der Ausatmungsstrom mit Stimmton hindurchgetrieben wird, ohne den Laut zu rollen. Im Gegensatz zum britischen Englisch wird es von der Mehrzahl der amerikanischen Sprecher vor allem im Auslaut und vor Konsonanten gesprochen, z. B.: father, farm.
(v)	very ('veri)	Aussprache des englischen (v) wie w in "Welt". Deutlich stimmhaft und mit stärkerem Reibegeräusch als im Deutschen.
(s)	soul (soul)	Stimmloses s, etwa wie in "reissen".
(z)	zone (zoun)	Stimmhaftes s, etwa wie in "Rose".
(ŋ)	long (lɔŋ)	Wie ng in "lang", aber ohne den im Deutschen häufigen g - oder k - Nachlaut.
(ʃ)	ship (ʃip)	Stimmlos wie deutsches sch, aber ohne Vorstülpen der Lippen oder Lippenrundung.
(ʒ)	measure ('meʒə)	Stimmhaftes sch wie es für g bzw. j in Wörtern französischen Ursprungs gesprochen wird: Journal.
(θ)	thin (θin)	Dieser Laut existiert im Deutschen nicht. Stimmloser Reibelaut. Die Zungenspitze wird an die Rückwand der oberen Schneidezähne angelegt. Häufig schiebt sich bei der Artikulation die Zungenspitze zwischen die oberen und unteren Schneidezähne. Kräftiges Reibegeräusch. Keinesfalls Ersetzung durch einen s - oder f - Laut.

(ð)	then (ðen)	Wie (θ) gebildet, aber deutlich stimmhaft.
(x)	loch (lɔx; lɔk)	Velarer Reibelaut wie ch in "ach"; nur im Schottischen üblich.

C. Halbvokale

(w)	water ('wɔ:tə)	Dieser Laut existiert im Deutschen nicht. Keinesfalls deutsches w oder v. Zungenstellung u. Lippenrundung wie bei (u:). Aus dieser Mundstellung heraus wird flüchtiges (u) gesprochen mit einem Hinübergleiten zum folgenden Vokal des betreffenden Wortes.
([h]w)	wheel ([h]wi:l)	Im amerikanischen Englisch wird in der Aussprache genau zwischen der w - und wh - Schreibung unterschieden. Bei wh - Wörtern wird (hw) gesprochen, d. h. ein Hauchlaut (h), dem sich unmittelbar ein (w) anschliesst.
(j)	yes (jes)	Im Unterschied zum deutschen (j) hat das englische (j) weniger Reibegeräusch. Es ist mehr ein Gleitlaut, der mit einem flüchtigen (i) beginnt und zum folgenden Vokal weitergleitet.

D. Betonungsakzente

Die Betonung der englischen Wörter wird durch Akzente vor den zu betonenden Silben angezeigt. (') bedeutet Hauptakzent, (,) Nebenakzent.

Tabelle I

Griechisches Alphabet - Greek Alphabet

Name	Capitals	Small letters	Commonly used to designate
Alpha	A	α ('ælfə)	Angles. Area. Coefficients
Beta	B	β ('biːtə) [US: 'beitə]	Angles. Flux density. Coefficients
Gamma	Γ	γ ('gaːmə, 'gæmə)	Angles. Conductivity. Specific gravity
Delta	Δ	δ ('deltə)	Variation. Density. Decrements. Increments
Epsilon	E	ε (ep'sailən) [US: 'epsilon]	Base of natural logarithms. E. m. f. Very small quantity
Zeta	Z	ζ ('ziːtə) [US: 'zeitə]	Impedance./Capital/ Coefficients. Coordinates
Eta	H	η ('iːtə) [US: 'eitə]	Hysteresis coefficient. Efficiency
Theta	Θ	ϑ ('θiːtə) [US: 'θeitə]	Temperature. Phase angle. Time constant
Iota	I	ι (ai'əutə)	Current in amperes
Kappa	K	ϰ ('kæpə)	Dielectric constant. Susceptibility. Visibility
Lambda	Λ	λ ('læmdə)	Wave length/Small/
Mu	M	μ (mjuː)	Amplification factor. Prefix micro-.Permeability
Nu	N	ν (njuː[US: nu])	Reluctivity
Xi	Ξ	ξ (ksai, sai, gzai)	Function variable. Amplitude
Omicron	O	ο (əu'maikrən) [US: 'omikron]	
Pi	Π	π (pai)	Ratio of circumference to diameter = 3,1416
Rho	P	ρ (rəu)	Resistivity
Sigma	Σ	σ ('sigmə)	Sign of summation /Capital/
Tau	T	τ (tau)	Time constant. Time-phase displacement
Upsilon	Υ	υ (juːp'sailən) [US: 'jupsilon]	
Phi	Φ	φ (fai)	Magnetic flux. Angles
Chi	X	χ (kai)	Reactance /Capital/
Psi	Ψ	ψ (psai)	Dielectric flux. Phase difference. Angles. Angular velocity in time
Omega	Ω	ω ('əumigə) [US: əu'megə]	Ohms /Capital/. Angular velocity /Lower case/

Tabelle II

Griechisches Alphabet in amerikanischen Symbolen

Greek Alphabet in American Letter Symbols

α	attenuation constant
	resistance - temperature coefficient
	degree of electrolytic dissociation
	angular acceleration
	absorption factor
	current transmission factor
	ratio of small difference in collector current to small difference in emitter current $/di_c/di_e/$
	current amplification
β	wavelength constant
	phase constant
Γ	reflection coefficient
γ	micrograms
	conductivity
	propagation constant
Δ	optical path difference
	finite difference
	permeance
δ	damping constant
	deflection
	load angle
ε	emissivity / radiation /
	capacitivity
	dielectric constant
	permittivity
ε_r	relative capacitivity
ε_v	capacitivity of evacuated space
ε_λ	special emissivity
ζ	electro-kinetic potential
η	efficiency
	electric susceptibility
	electrolytic polarization

θ	transfer constant
	temperature
	impedance angle
κ	magnetic volume susceptibility
Λ	equivalent
	conductance
	permeance
λ	linear charge density
	wavelength
	transducer
μ	magnetic permeability
	dipole moment
	grid control ratio
	refractive index
	micro /n/
	permeability
	amplification factor
	radiant density
μa	microammeter
	microampere
μf	microfarad
μh	microhenry
μ_0	initial permeability
	permeability of free space
	Bohr magneton
μ_r	relative permeability
μ_v	permeability of free space
$\mu\mu$	micromicro- /prefix/
$\mu\mu f$	micromicrofarad
ν	reluctivity
	frequency of radiant
	energy
Π	Poynting vector
π	electrolytic polarization
ρ	volume charge density

	specific resistance
	resistivity
	reflection factor
σ	surface charge density
	conductivity
	Stefan-Boltzmann constant
	magnetic leakage coefficient
	specific conductance
τ	transmission factor
	time constant
Φ	magnetic flux
	radiant flux
φ	angle
	phase
χ	Volume of magnetic susceptibility
Ψ	electric flux
	flux displacement
	wave function
	Planck function
Ω	ohm
ω	angular velocity
	specific magnetic rotation
	circular frequency

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